DOCUMENT RESUME

ED 466 952 SE 065 999

TITLE	NOVA[R] Spring 2001 Teacher's Guide.
INSTITUTION	WGBH-TV, Boston, MA.
PUB DATE	2001-00-00
NOTE	55p.; Funded by Northwestern Mutual Financial Network, Park Foundation, and Sprint PCS.
AVAILABLE FROM	WGBH Educational Foundation, NOVA Teacher's Guide, 125 Western Avenue, Boston, MA 02134. Web site: http://www.pbs.org/nova/teachers/guidesubscribe.html.
PUB TYPE	Guides - Classroom - Teacher (052)
EDRS PRICE	EDRS Price MF01/PC03 Plus Postage.
DESCRIPTORS	Archaeology; Elementary Secondary Education; *Genetics; Medicine; *Science Activities; *Science Instruction; Science Interests; Teaching Guides
IDENTIFIERS	NOVA (Television Series)

ABSTRACT

This teacher's guide is designed to accompany the PBS television program "NOVA" and features six activities. "Sultan's Lost Treasure" presents the attempts of an archaeologist and his team to salvage an ancient ship wreck. "Vanished!" investigates what happened to the Stardust airliner in 1947 which disappeared during a flight. "Lost King of the Maya" explores a Mayan burial site. "Survivor MD" explains the progress of medical students becoming doctors. "Cracking the Code of Life" discusses the human genome. "Genetically Modified Foods" presents debates on genetically engineered foods. (YDS)

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NOVA Spring 2001
Teacher's Guide

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NOVA

Spring 2001 Teacher's Guide

Major funding is provided by
Northwestern Mutual FINANCIAL NETWORK
PARK FOUNDATION
Sprint. Sprint PCS

Lost King of the Maya

page 14

2A

The future of a country lies in its young people, and the future of those young people lies in their teachers. As an educator, you know that shaping a future means working hard in the present.

I understand how much support you need in this effort, because helping shape futures is our business at Northwestern Mutual. The Financial Representatives of the Northwestern Mutual Financial Network provide expert guidance to help people put together personal financial strategies that will make a positive difference throughout their lives.

So it's with an eye toward the future that the Northwestern Mutual Foundation offers you the new spring issue of the *NOVA Teacher's Guide*. I know this season's shows are full of interesting material for study and the guide will turn them into a powerful teaching aid in your classroom. As proud sponsors of this award-winning educational series, everyone here at Northwestern Mutual would like to thank you for your integrity and dedication to shaping the future.

James D. Ericson
President and Chief Executive Officer

Northwestern Mutual
FINANCIAL NETWORK

The Park Foundation is committed to education and quality television. We are pleased to be able to advance the work of NOVA, the preeminent television series in science education. As you know, through study of science, young people acquire skills, knowledge, and — most of all — an intellectual curiosity.

The *NOVA Teacher's Guide* serves as an excellent supplement for your use. We are grateful to you for introducing students to the world of science.

PARK
FOUNDATION

Contents & Broadcast Schedule

Schedule Changes

Because of potential programming changes after April 1, 2001, NOVA programs listed here may not air on their currently-scheduled date or time. Please check your local listings after April 1 for final program information. Or, sign up for the NOVA Online Teacher's Mailing List. List members receive messages alerting them to upcoming NOVA programs a week ahead of time, including program and Web site summaries.

Sign up at:
www.pbs.org/nova/teachers/listsubscribe.html

		Earth & Space Science	General Science	Life Science	Physical Science	Social Studies	NOVA Activity
2	**NOVA in the Classroom** Find out what's new on NOVA Online and how NOVA is being used in classrooms nationwide.						
	Lost on Everest* (R) Week of Jan. 2 • www.pbs.org/nova/everest/		●			●	
4	**Sultan's Lost Treasure*** Week of Jan. 16 • www.pbs.org/nova/sultan/		●			●	
10	**Vanished!*** Week of Jan. 30 • www.pbs.org/nova/vanished/		●			●	
	Nazi Prison Escape* Week of Feb. 6 • www.pbs.org/nova/naziprison/		●			●	
14	**Lost King of the Maya*** Week of Feb. 13 • www.pbs.org/nova/maya/		●			●	
	Cancer Warrior* Week of Feb. 27 • www.pbs.org/nova/cancer/			●			
	Warnings from the Ice* (R) Week of March 20 • www.pbs.org/nova/warnings/	●					
18	**Survivor MD* (3 hours)** Weeks of March 27, April 3, and April 10 • www.pbs.org/nova/doctors/		●			●	
24	**Cracking the Code of Life* (2 hours)** Week of April 17 • www.pbs.org/nova/genome/			●		●	
36	**Genetically Modified Foods*+ (2 hours)** Week of April 24 • www.pbs.org/wgbh/gmfoods/		●	●		●	
	Trillion Dollar Bet* (R) Week of May 1 • www.pbs.org/nova/stockmarket/		●				
	Secrets of Lost Empires II: Medieval Siege* (R) Week of May 15 • www.pbs.org/nova/lostempires/		●		●	●	
	Secrets of Lost Empires II: Pharaoh's Obelisk* (R) Week of May 22 • www.pbs.org/nova/lostempires/		●		●	●	
	Secrets of Lost Empires II: Easter Island* (R) Week of May 29 • www.pbs.org/nova/lostempires/		●		●	●	
40	**NOVA Video Catalog**						
48	**Ordering Information**						

Because of schedule changes, some NOVA programs do not have lessons.

* one-year off-air taping rights

\+ program title may change

(R) indicates a repeat program

lesson within this guide

lesson online at: www.pbs.org/nova/teachers/teachersguide.html

NOVA in the Classroom

A Genetics Revolution

Dear Educators,

Everyone's talking about genetics—from the mapping of the human genome to the controversy over genetically engineered foods. NOVA is excited to dedicate two spring programs to this phenomenal revolution. In April, NOVA broadcasts "Cracking the Code of Life," a two-hour special revealing the promise, peril, profits, and personalities behind the mapping of the human genome.

Also in the news is the proliferation of genetically engineered foods. Is this technology an answer to world hunger or the opening of Pandora's box? Explore the issues in "Genetically Modified Foods," a NOVA/FRONTLINE co-production airing in April.

Other programs you'll see this season address the discovery of a plane lost for 53 years, the underwater excavation of a 15th-century Chinese junk, a look at a novel approach to cancer treatment, and the excavation of the tomb of Yax K'uk Mo', founder of the Mayan dynasty in Copán.

I'd like to close by drawing your attention to a fascinating series that NOVA began 14 years ago, when it started following seven Harvard University medical students on their journey to become doctors. In a new installment, we see where some of these people are now and hear them discuss their lives as doctors.

Paula S. Apsell

Paula S. Apsell
NOVA Executive Producer

NOVA Online's Teachers Site www.pbs.org/nova/teachers/

Teacher's Guide
Locate printable lessons to use with NOVA programs.

Sign Up for Weekly Updates
Would you like to know what's coming up on NOVA each week, both on television and the Web site? Join our mailing list and find out. Each week we'll send you a reminder of the date and title of the following week's broadcast, and what you'll find online to help you integrate the Web into your curriculum. And we'll keep you abreast of any special programs or online adventures we're planning.

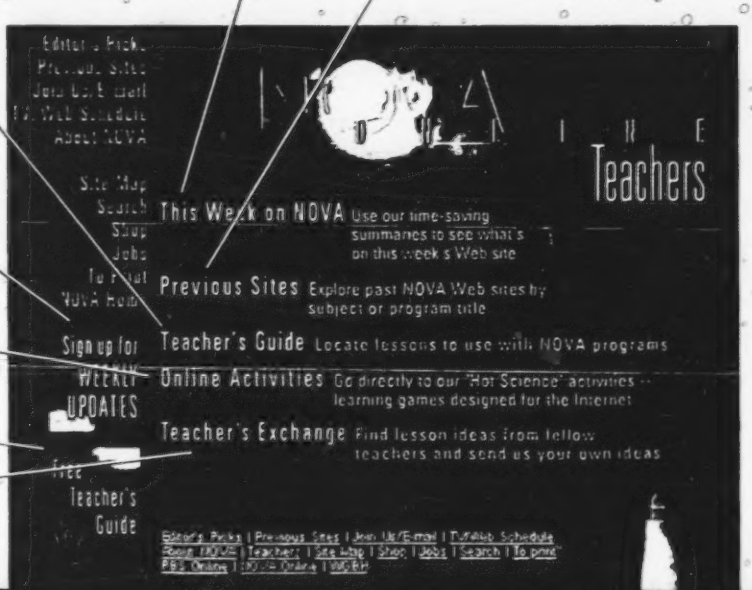
Online Activities
Find activities designed especially for the Internet.

Free Guide
Sign up to receive your free teacher's guide, by mail, twice a year.

Teacher's Exchange
Read lesson ideas from fellow teachers and send us your own ideas.

This Week on NOVA
This section features a listing of the science articles, multimedia presentations, and activities on the Web site that accompany the current NOVA program. Brief descriptions and grade-level designations are provided for everything on the site.

Previous Sites
Obtain access to Web content by program title or subject area for previous NOVA programs.


Teachers
This Week on NOVA Use our time-saving summaries to see what's on this week's Web site
Previous Sites Explore past NOVA Web sites by subject or program title
Teacher's Guide Locate lessons to use with NOVA programs
Online Activities Go directly to our "Hot Science" activities -- learning games designed for the Internet
Teacher's Exchange Find lesson ideas from fellow teachers and send us your own ideas
Sign up for WEEKLY UPDATES
Free Teacher's Guide
5

NOVA Featured Teacher

What's Up With the Weather?

Teaching about the environment isn't new for David MacIver, who has been teaching ecology and environmental science since the first Earth Day in 1970. MacIver, who often uses NOVA programs in his class, was delighted to find the NOVA/FRONTLINE program "What's Up With the Weather?" and accompanying Temperature Trends activity in the *NOVA Teacher's Guide* as part of the Spring 2000 lineup.

MacIver, who teaches at Southwick-Tolland Regional High School in Southwick, Massachusetts, begins a unit on climate change and the greenhouse effect by showing students the NOVA program.

Students are then asked to observe and describe patterns in the activity's raw data. Then, MacIver either divides the class into groups and has each group graph one year of the data or has every student graph all 10 years of Boston monthly average temperatures found in the activity. Students then examine the graphs once they are taped together. MacIver, whose class includes both Honors and Special Education students, finds the activity easily adaptable.

MacIver then graphs each year of data onto separate overhead transparencies using a different-colored marker or kind of line (e.g., solid or dashed) to distinguish each year. MacIver then overlays the overheads one at a time. When all graphs are in place, students notice seasonal temperature patterns and are often surprised to see minimal warming. This leads to a discussion of whether looking at 10 years of data from one location is sufficient to make predictions about global warming or long-term climate change.

Next, students calculate the moving average for the data. MacIver likes the integration of mathematics into the activity, but says this is often the most difficult part for his students. Depending on individuals' abilities, MacIver has students either calculate and graph the moving average for all 10 years, or calculate it for one year and then use the chart provided in the activity answer to graph the remaining data. MacIver then displays a second set of overheads he has created with graphs of the moving average data for each year. Through these, students observe that seasonal differences in the data disappear and that the data is more like the mean temperature for Boston. Students then discuss how different interpretations can be drawn from the same data set depending on how the data is presented.

Students Chris Sims, left, and Adreana Allaire compare yearly temperature data as teacher David MacIver looks on.

As an extension, MacIver has students compare the Boston data to worldwide temperature data from 1960 to 1999, gathered from the Climatic Research Unit at East Anglia University **(www.cru.uea.ac.uk/)** in the United Kingdom. MacIver notes that examining the data on a longer time scale and comparing local and global temperatures helps students make predictions about long-term climate change and see the warming trend that scientists discuss in the NOVA program. MacIver concludes the lesson with a class debate about whether global warming is the result of anthropogenic activities or part of a natural cycle.

For more information on MacIver's project, you can e-mail him at: **revicam_568@yahoo.com**

Become a NOVA Featured Teacher

We'd like to hear from YOU! Tell us how you're using a NOVA program or NOVA Online in your classroom.

Send your comments to:
www.pbs.org/nova/teachers/teacherex.html
and we'll post them in our Lesson Ideas section.
Or send your ideas to:

Gay Mohrbacher
WGBH
125 Western Avenue
Boston, MA 02134
Gay_Mohrbacher@wgbh.org

If we choose to feature your classroom in our *NOVA Teacher's Guide*, we'll send you and your students six free NOVA videos or two Classroom Field Trip kits of your choice.

Program Contents

NOVA follows archaeologist Michel L'Hour and his team as they attempt to salvage an ancient shipwreck in one of the largest marine archaeological projects ever undertaken.

The program:

- tracks divers as they descend 197 feet (60 meters) to place large metal grids on the ocean floor around the wreck, which will enable archaeologists to plot the site.
- notes that the shipwreck lays at the center of what used to be a vast trading network that included ports in China, Thailand, Vietnam, and Borneo.
- traces the first of China's seven great 15th-century trading expeditions.
- relates reasons why China decided to decrease its maritime presence and limit foreign trade.
- details how more than 15,000 different items were recovered, many with origins in different ports of late 15th-century Asia.
- depicts how artifacts are restored, dated, and catalogued.
- includes a computer simulation of what the ship originally might have looked like, and how its items have been distributed.
- notes that many years of continued research on the artifacts is necessary before all the items will be identified and catalogued.

Before Watching

1. Have the students locate China, the China Sea, Vietnam, Thailand, and Brunei on a world map or globe and trace possible trade routes among the countries.

2. Archaeologists use evidence to infer facts about a shipwreck and its contents. As students watch, have them make a chart of the different kinds of evidence that were collected and what was inferred from each type.

During the excavation, artifacts like this blue and white porcelain plate were classified by their shape, size, and type of decoration.

After Watching

1. Archaeologists draw conclusions from all available evidence. Compare student charts that list what archaeologists found and concluded, and discuss whether students think the inferences archaeologists made were valid. What evidence could the scientists use to support their theories? What evidence was most helpful and why? What kinds of information about a culture can be learned from artifacts like these?

Activity Setup

Objective

To interpret information about a set of artifacts.

Materials for each group

- copy of *Artifact Cards* activity sheets on pages 7–8
- 4 envelopes
- copy of the *Where, When, and Who?* activity sheet on page 6
- access to print and Internet resources (see *Activity Answer* on page 9 for suggested resources)

Procedure

1. Make a copy of the *Artifact Cards* activity sheets and cut out the images. Place the four sets into separate envelopes. You may want to have the cards laminated so you can use them again.
2. Organize students into four groups. Tell each group they have been hired by the Museum of Anthropology to sort through boxes of archaeological artifacts and try to infer as much as they can from the evidence they find.
3. Give each group an envelope with a set of artifacts. Have students examine the artifacts and use any prior knowledge and resources to determine:
   - the country represented
   - the time period
   - the person associated with the items
4. You may want to tell students that the person associated with the items is not actually pictured in any of the items.
5. Direct students to look at each item individually and then at all the items as a whole before drawing their final conclusions.
6. Have students write a report describing their archaeological find.

Standards Connection

The activity found on pages 6–8 aligns with the following *National Science Education Standards*.

Grades 5-8

Science Standard A:
Science as Inquiry

Abilities necessary to do scientific inquiry

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.

Grades 9-12

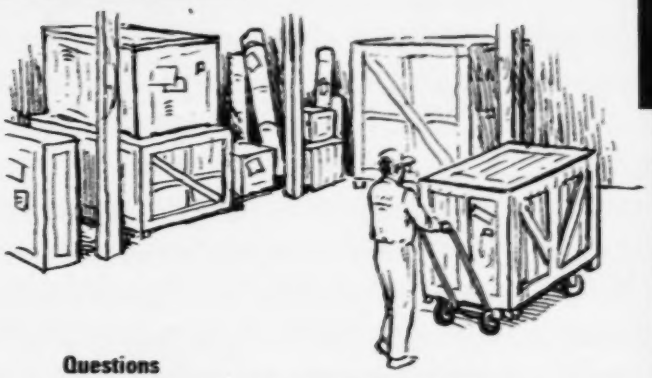
Science Standard A:
Science as Inquiry

Abilities necessary to do scientific inquiry

- Formulate and revise scientific explanations and models using logic and evidence.

Where, When, and Who?

NOVA Activity I **Sultan's Lost Treasure**



You have been hired to help curators at the Museum of Anthropology. They have come across a number of older, unopened boxes that contain artifacts—or pieces of artifacts—from archaeological expeditions. The museum wants you to sort through the artifacts and infer what country they came from, what time period they are from, and with whom they are associated.

Procedure

1. Empty the contents of your envelope onto a desk.
2. Look at each one of the artifacts from the envelope individually and then as a full set. Can anyone in your group identify any of them? Use resources suggested by your teacher for further identification and record your findings in your *Artifact Log* below.
3. Once you have identified as many artifacts as you can, look at the artifacts all together again and make some inferences about what you have found in your museum box.

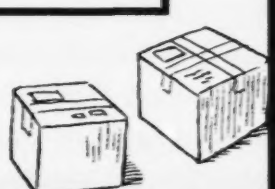
Questions

Write your answers on a separate sheet of paper.

1. What country seems to be represented?
2. What time period seems to be represented?
3. Who is the historical person you would most closely associate with the artifacts?
4. Which artifacts were the most useful in helping you make your inferences? Which ones were least useful and why?

Artifact Log

Artifact	What do you think this artifact is?	What can you infer about this artifact?
1		
2		
3		
4		
5		
6		
7		
8		

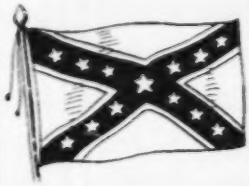


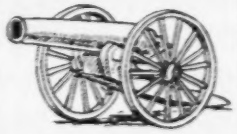
Artifact Cards

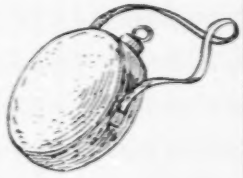
NOVA Activity | **Sultan's Lost Treasure**

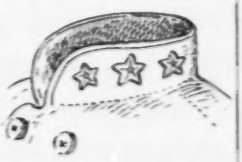
BOX 1

...One brief month ago we were apparently at the point of success. Lee was in Pennsylvania threatening Harrisburg—

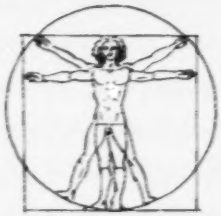






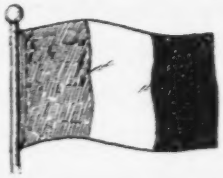


BOX 2



abranos

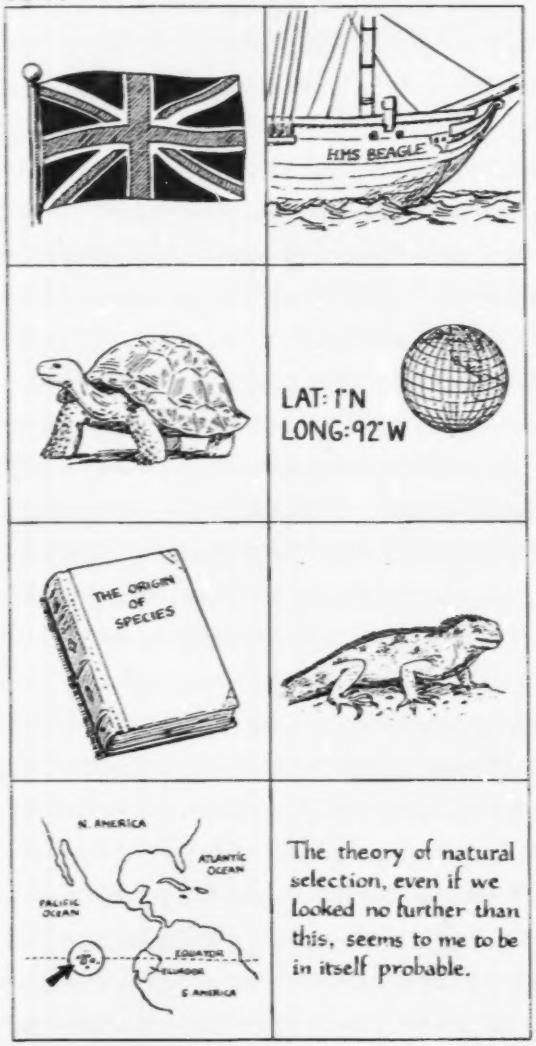
APRIL 15, 1452



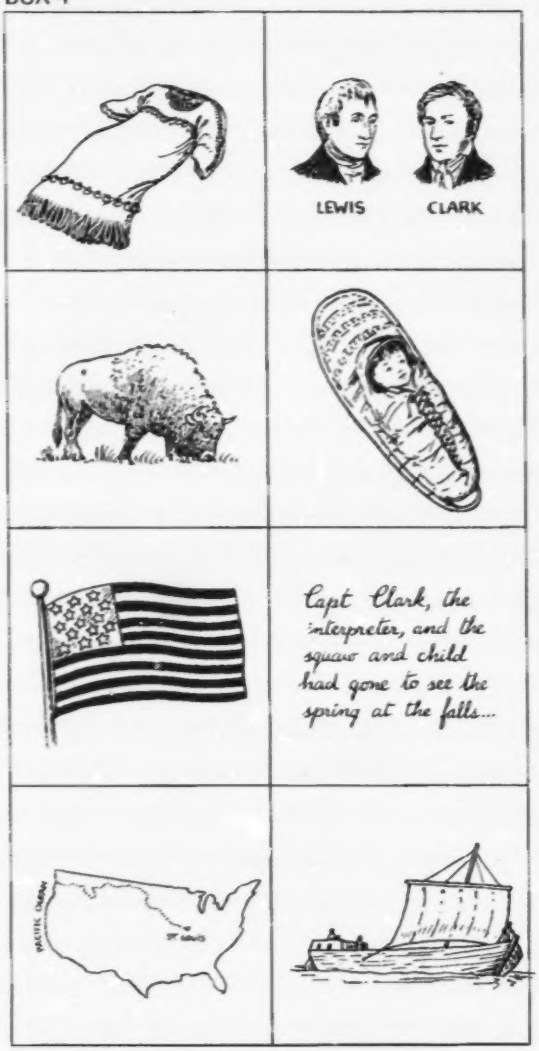
Artifact Cards

NOVA Activity I **Sultan's Lost Treasure**

BOX 3


HMS BEAGLE
LAT: 1°N
LONG: 92°W
THE ORIGIN OF SPECIES
N. AMERICA
ATLANTIC OCEAN
PACIFIC OCEAN
EQUATOR
S. AMERICA
The theory of natural selection, even if we looked no further than this, seems to me to be in itself probable.

BOX 4



Activity Answer

Students may identify some artifacts using only prior knowledge. Once students look at the artifacts in a group, they may be able to go back and identify individual items.

Students should use specific clues within the collection of artifacts to get their research started. For example, all boxes contain images of flags indicating the country of origin.

Other clues should help students begin to unravel more information about the contents of their box. For example, **Box 1** (Robert E. Lee) includes much Civil War paraphernalia, a journal entry that mentions Lee's name, and a drawing of Lee's horse, Traveler. **Box 2** (Leonardo da Vinci), contains da Vinci's birthdate as well as three of his well-known paintings and sketches. **Box 3** (Charles Darwin) holds many clues about Darwin's research in the Galapagos and the resulting paper, *The Origin of Species*. **Box 4** (Sacagewea) contains clues to Lewis and Clark's journey and hints to Sacagewea's baby.

Box 1: Robert E. Lee **Country:** United States
Time Period: 1807–1870
Artifacts: • canteen • confederate cap
• general's three-star epaulette • Lee's horse, Traveler
• canon • rifle with bayonet • confederate flag
• diary excerpt from field officer
Resources: encyclopedia, American history textbooks, Internet

Box 2: Leonardo da Vinci **Country:** Italy
Time Period: 1452–1519
Artifacts: • his sketch called "Vitruvian Man"
• outline of Italy • aerial screw invention
• portrait of Mona Lisa • Italian flag
• document containing birthdate: April 15, 1452
• Leonardo's signature, as he wrote it backwards
• his drawing of wing structure
Resources: encyclopedia, art history textbooks, Internet

Box 3: Charles Darwin **Country:** England
Time Period: 1809–1882
Artifacts: • British flag • cover of *Origin of Species*
• sketch of the HMS Beagle • Galapagos iguana
• Galapagos turtle • excerpt from *Origin of Species*
• chart showing Galapagos latitude/longitude
• outline of North and South America
Resources: atlas, encyclopedia, general science textbooks, biology textbooks, Internet

Box 4: Sacagawea **Country:** United States
Time Period: 1784–1884
Artifacts: • Shoshone woman's dress
• portrait of Lewis and Clark • Shoshone papoose • buffalo
• U.S. flag of the period • Corps of Discovery journal entry
• mapped route to Pacific along rivers
• image of boat used to navigate the Western rivers
Resources: atlas, encyclopedia, American history textbooks

Resources

Book

Gould, Richard.
Archaeology and the Social History of Ships.
New York: Cambridge University Press, 2000.
Explains how underwater archaeology has become a key branch of the science.

Article

Dahlby, Tracy and Michael Yamashita.
"Crossroads of Asia: South China Sea."
National Geographic, December 1998, 2–5.
Describes the bustling trade that built the fortunes of cities surrounding the South China Sea.

Web Sites

NOVA Online—Sultan's Lost Treasure
www.pbs.org/nova/sultan/
Provides program-related articles, interviews, interactive activities, resources, and more.

Basic Methods of Conserving Underwater Archaeological Material Culture
nautarch.tamu.edu/class/ANTH605/File0.htm
Gives an overview of basic conservation procedures, then specifically addresses material types including bone, pottery, glass, wood, and metals, and their conservation.

Darwin's *The Origin of Species*
www.literature.org/authors/darwin-charles/
Allows you to read the text of Charles Darwin's work in full.

Exploring Leonardo
www.mos.org/Leonardo/
Offers an online tour of the 1997 exhibit at Boston's Museum of Science about the inventions and scientific method of Leonardo da Vinci.

PBS Online—Lewis & Clark: The Journey of the Corps of Discovery
www.pbs.org/lewisandclark/
Details the four-year adventure and scientific expedition of Meriwether Lewis and William Clark to explore the uncharted West.

Program Contents

In 1947, *Stardust*, an airliner converted from a World War II bomber, disappeared on a flight from Buenos Aires to Santiago without a trace. Fifty-three years later, NOVA follows an international team using modern scientific methods to piece together what happened and why.

The program:

- describes the circumstances of the flight's sudden disappearance in South America's Andes mountains and relates theories that evolved in the absence of hard information.
- recounts the discovery of one of *Stardust's* engines as well as personal effects on the glacier below Mount Tupangato.
- explains how analyzing the wreckage distribution is critical to discovering what happened, because different types of crashes leave different patterns on the ground.
- outlines the various crash theories considered by investigators.
- reviews the team's final theory on what probably happened: *Stardust* crashed on the eastern face of Tupangato and its wreckage was first covered by avalanche and then carried away by glacial flow.
- speculates the plane crashed because flight crew members encountered stronger winds than they had calculated for, which altered their flight path without the crew's knowledge.
- explores how navigation practices of the 1940s and lack of knowledge of the jet stream may have contributed to the crash.

Before Watching

1. Have students locate Buenos Aires and Santiago on a map of South America and trace *Stardust's* route between them over the Andes range. How high is the range in that area? What considerations would there be in placing an airport so close to the mountains?

2. As students watch, have them chart information about each piece of evidence and possible conclusions.

Finding one of the two giant wheels provided additional clues about the crash.

After Watching

1. In the program, investigators originally had one idea of what might have occurred and then modified that idea as new evidence was found. Ask students for an example of a time when their initial conclusions about something changed based on their being open to new facts or more logical reasoning. Have them consider situations such as when they met a new person who seemed unfriendly, but turned out just to be shy. Or an experiment they may have done recently in which their conclusions changed based on their results.

Activity Setup

Objective

To trace the development of how a hypothesis changes based on new evidence.

Materials for each student

- copy of *What Happened to Stardust?* activity sheet on page 12

Procedure

1. As part of the scientific investigation of the *Stardust* crash site, scientists proposed possible theories and made a list of specific wreckage that would confirm or refute their theories. Sometimes the wreckage presented another question to be answered. In this activity, students will follow the process scientists went through.
2. Distribute copies of the *What Happened to Stardust?* activity sheet. While they watch the program, have students fill in the information about each piece of evidence (i.e., where it was found, the condition in which it was found) and possible conclusions. Direct students to look only for the information that deals with what happened to the plane, not about why it crashed, which is presented in the latter part of the program.
3. After students have watched the program, as a class review the information they collected, as well as any additional evidence students saw presented. Have students answer the questions about the fate of *Stardust*. After reviewing conclusions about what happened to *Stardust*, clear up any remaining questions students may have.
4. As an *extension*, have students research current unsolved plane crashes. How many are there? Have students note the first hypotheses that surface immediately after a plane crash. How do any final conclusions differ from initial ideas regarding the crash? How certain are investigators about their conclusions? What questions remain?

Standards Connection

The activity found on page 12 aligns with the following *National Science Education Standards*.

Grades 5-8

Science Standard G:
History and Nature of Science

Nature of Science

- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists. Evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations.

Grades 9-12

Science Standard G:
History and Nature of Science

Nature of Scientific Knowledge

- Scientific explanations must meet certain criteria. First and foremost, they must be consistent with experimental and observational evidence about nature and must make accurate predictions, when appropriate, about the systems being studied. They should also be logical, respect the rules of evidence, be open to criticism, report methods and procedures, and make knowledge public.

What Happened to Stardust?

NOVA Activity I **Vanished!**

In 1947, the airplane *Stardust* disappeared on a flight from Buenos Aires, Argentina, to Santiago, Chile, without a trace. Investigators were stumped and many theories were proposed, from the airplane crashing into a mountain or glacier to it being blown up or abducted by aliens. It wasn't until 53 years later that some of the plane's pieces began to reappear. Follow investigators as they try to solve the mystery of what happened.

Procedure

Make a chart like the one below on a separate sheet of paper.

1. While watching the program, take notes on the evidence and possible conclusions made by investigators.
2. Following the program, work with the other students in your class to fill out any missing information in your chart and answer the questions that follow.

Questions

Write your answers on a separate sheet of paper.

1. Was the engine running when the plane crashed? How do you know?
2. Where did the plane crash?
3. Why do you think the plane crashed?
4. What question remained after investigators had collected and analyzed all the evidence?

Evidence	Information about Evidence	Possible Conclusions
• Rolls Royce engine		
• first pieces of wreckage		
• two main wheels		
• various wreckage		
• human remains		
• tail landing gear, minus its wheel		
• propeller		
• other evidence?		
• other evidence?		

Activity Answer

Investigators working to unravel the mystery of what happened to the *Stardust* flight began their investigation with one idea of what may have happened and then modified their hypothesis as they discovered new evidence.

After examining all the wreckage, investigators concluded that the plane flew into the mountainside—the wreckage was spread too far for a nose dive into the ground, but not far enough for a bomb. But one question remained: Why was the wreckage so far from the mountain where the plane was thought to crash?

This inconsistency in the evidence generated a new theory: The glacier below the mountain may have transported the wreckage from close to the mountain where the plane crashed to a new position farther away. And if the wreckage had been carried inside the glacier this would explain why it was hidden for 53 years.

Once they had solved the mystery of what happened to the plane, investigators were still left with the question of why it occurred. After looking at the available evidence, they concluded that severe headwinds had a devastating impact on *Stardust's* progress, unknown to the crew, which kept it from travelling all the way across the mountains before it began to turn south toward Mount Tupangato. Thinking they were near their destination, crew members may have begun the plane's descent too early, sending the plane into the mountain.

The following is a sampling of some of the evidence and additional information about the *Stardust* disappearance. Students may generate additional ideas.

Evidence	Additional Information
• Rolls Royce engine	• found on glacier below Mount Tupangato
• first pieces of wreckage	• found more than .62 miles (1 kilometer) from mountain
• two main wheels	• found farther down the mountain from wreckage • brake is engaged
• various wreckage	• found scattered, but contained within a kilometer or so
• human remains	• brutally torn
• tail landing gear, minus its wheel	• found 547 yards (500 meters) or more away from main wheels
• propeller	• propeller's blades turned back; propeller not feathered

Resources

Organization
National Transportation Safety Board (NTSB)
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594
(202) 314-6000
The independent Federal agency that investigates every U.S. civil aviation accident. The NTSB's investigative process is detailed online at: **www.ntsb.gov/abt_ntsb/invest.htm**, *and updates on major investigations and statistics on aviation accidents are online at:* **www.ntsb.gov/aviation/aviation.htm**

Book
Post, Austin, and Edward R. Lachapelle.
Glacier Ice.
Seattle, WA: University of Washington Press, May 2000.
Combines more than 100 photographs with a discussion of the effects of glaciers on the landscape, glacier formation and mass balance, flow and fluctuations, and surface details. Includes ground-based photographs from South American ranges.

Web Sites
NOVA Online—Vanished!
www.pbs.org/nova/vanished/
Provides program-related articles, interviews, interactive activities, resources, and more.

Forensic Science Links
www.cj.msu.edu/~academic/forenlinks.html
Provides links to many branches of forensic science, including those that play a role in plane crash investigations.

All about Glaciers
nsidc.colorado.edu/glaciers/
Includes facts, historic photos, an extensive glossary, and other links to glacier information. The Glacier Story page offers a quick tour through the life of a glacier.

Lost King of the Maya

Airs the week of February 13 • www.pbs.org/nova/maya/

Program Contents

NOVA follows archaeologist Bill Fash and his team as they excavate the burial site of the founder of a Maya dynasty in Copán, Honduras, and explores startling new information about Copán revealed by linguistic analysis and biological anthropology.

The program:

- introduces Yax K'uk Mo', the legendary king who entered Copán as a conqueror and remained to found a dynasty.
- reviews the history of the Maya people, who built towering pyramids and developed sophisticated systems of writing and astronomy more than a thousand years ago.
- reveals the involvement of the Maya in ritual warfare and human sacrifice.
- examines the purpose of Maya observations of the stars and planets.
- recounts how the Maya symbol code was broken in the 1980s.
- chronicles the 400-year dynasty of Maya Holy Lords, founded by Yax K'uk Mo'.
- offers a new historical insight into the collapse of the Maya empire.

Before Watching

1. Copán is one of the most important archaeological sites of Maya civilization. Using a world atlas, help students locate Copán.

Sculpture of Yax K'uk Mo', the founder of the 400-year-old dynasty of Copán.

After Watching

1. There are many way to keep track of time. Ask students to brainstorm various ways to record the passage of time. Why is it important to track time? How does time correspond to different seasons? Have students investigate and report on different calendar systems, such as Julian, Gregorian, Hebrew, Islamic, Maya, or Chinese calendars.

Activity Setup

Objective

To understand and apply the Maya Long Count calendar system.

Materials for each student

- copy of the *Calendar Count* activity sheet on page 16
- calculator

Procedure

1. Read the activity sheet to familiarize yourself with the calculations that students will make.
2. Organize students in groups. Distribute copies of the *Calendar Count* activity sheet.
3. Tell students they will be calculating the date of their birth in the Maya Long Count calendar system. The Maya Long Count system uses a base 20 number system. Review the difference between the base 10 system, which students are familiar with, and a base 20 system.
4. Assist students in calculating their birth date according to Maya Long Count. If students are having problems converting their total days into long count, tell them that they need to start by determining how many baktun divide *evenly* into the total number of days. Next, they should determine how many katun divide evenly into the balance of days left. Then proceed, in turn, to tun, uinal, and kin.
5. As an *extension*, have student calculate how many days until the Fourth Creation ends (December 22, 2012) and how many total days are in the Fourth Creation.

Standards Connection

The activity found on page 16 aligns with the following *Principles and Standards for School Mathematics*.

Grades 6-8

Mathematics Standard:
Number and Operations

Grades 9-12

Mathematics Standard:
Number and Operations

Calendar Count

NOVA Activity I **Lost King of the Maya**

If someone asks you when your birth date was, you probably answer them by giving a month, day, and year. But that's not the only way to record passing time. Different cultures have used different calendar systems to mark time. One such system used by the Maya culture is called the Maya Long Count. In this activity, you'll figure out your birth date in Maya Long Count.

Part I

Most people today measure time in days, months, years, decades, and centuries, based on what's known as the Gregorian calendar system. The ancient Maya measured time in kins, uinals, katuns, and baktuns based on the Maya Long Count system. The numbers add up to the number of days since the beginning of the Maya Fourth Creation (which is calculated as August 13, 3114 B.C.E., on the Gregorian calendar used today).

Procedure

① Your first task is to convert a Maya Long Count date into days. In Maya Long Count, the date December 31, 1979 is recorded as **12.18.6.9.14**

② Use the *Maya Long Count Conversions* chart below to convert each Long Count place value in the date above to days and then add up all five values to calculate the total number of days. Write your answer below.

Days from the beginning of the Maya Fourth Creation to December 31, 1979 = _____

Maya Long Count Conversions

Maya Long Count dates are written as a series of numbers separated by periods.

_____ . _____ . _____ . _____ . _____

baktun katun tun uinal kin

baktun = 144,000 days
katun = 7,200 days
tun = 360 days
uinal = 20 days
kin = 1 day

Part II

Procedure

① Now, using the *Days in Each Month/Year* chart below, calculate how many days there are from January 1, 1980, to the day you were born. Note that leap years have an extra day in February.

Your Birth Date _____

Days from January 1, 1980, to your birth date = _____

Days in Each Month/Year

(Leap years are noted in **bold**.)

Days in month	Days in year
January = 31	**1980 = 366**
February = 28/29	1981 = 365
March = 31	1982 = 365
April = 30	1983 = 365
May = 31	**1984 = 366**
June = 30	1985 = 365
July = 31	1986 = 365
August = 31	1987 = 365
September = 30	**1988 = 366**
October = 31	1989 = 365
November = 30	1990 = 365
December = 31	

Part III

Procedure

① Add the number of days from the beginning of the Maya Fourth Creation to December 31, 1979, and the number of days from January 1, 1980, to your birth date. Write the total in below.

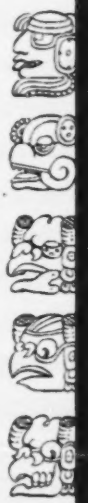
Days from the beginning of the Maya Fourth Creation to your birth date = _____

② Now it's time to convert the number of days since the Maya Fourth Creation to your birth date back into Maya Long Count. Use the *Maya Long Count Conversions* chart to turn the number of days into Long Count. Write the conversions in below.

_____ . _____ . _____ . _____ . _____

baktun katun tun uinal kin

③ Congratulations! Now when somebody asks you when you were born, you can say "Do you want to know by the Gregorian calendar or Maya Long Count?"



Activity Answer

The Maya used three different calendar systems. One of them, called the Calendar Round, combined the tzolkin calendar—a sacred count of 260 days—and the haab calendar, a solar count of 365 days, which when used together could track unique days up to 52 years. In order to track time over a longer period, the Maya coordinated the Calendar Round with the Long Count, which is based on the number of days from a set point: the beginning date of the Fourth Creation (0.0.0.0.0), equivalent to August 13, 3114 B.C.E. in the modern calendar system. (Each zero date is considered the most recent of an infinite series of zero dates, which repeat every five thousand years or so.)

The Long Count works on a base 20 system. The following are the equivalencies for the units necessary to calculate time in a 5,000+-year Creation.

Days from the beginning of the Maya Fourth Creation to December 31, 1979:
12.18.6.9.14 =

12 baktuns x 144,000 days =	1,728,000
18 katuns x 7,200 days =	129,600
6 tuns x 360 days =	2,160
9 uinal x 20 days =	180
14 kin x 1 day =	14
TOTAL =	**1,859,954**

The number of days to each student's birth date will vary. Check to make sure students include the extra day for each leap year, and the day of their birth. Students will add the number of days from 1980 to their birth date to the number of days they converted in the first part of the activity. Students will then use the conversion chart to convert the number of total days back into Maya Long Count. They should take the largest equivalent first (baktun at 144,000 days) and calculate by division how many baktun go evenly into their total number. (In the total above, 1,859,954, the answer is 12 baktun, leaving a balance of days at 131,954.) Students should then move successively down to the smallest equivalent (kin at 1 day) following the same procedure.

The Fourth Creation will be completed on December 22, 2012 C.E., the Maya date of 12.19.19.17.19. Scholars disagree on the precise correlation of the Gregorian and Maya calendars. Their disagreements turn on differences of days, not decades. A correlation is necessary to equate a Gregorian date with a Maya date; this means finding a particular date that is identified by both systems. For this activity, the correlation for the most recent day of Maya Long Count 0.0.0.0.0 is 584,285 days on the Gregorian calendar, thus the first day of the Maya Long Count would be the 584,286th day on the Gregorian calendar. This correlation is incorporated into all Long Count calculation in this activity.

Resources

Book

Schele, Linda, and David Freidel.
A Forest of Kings: The Untold Story of the Ancient Maya.
New York: Quill/W. Morrow and Co., 1992
Brings to life the rulers of the ancient Maya, with scholarly work that reads like short stories.

Web Sites

NOVA Online—Lost King of the Maya
www.pbs.org/nova/maya/
Provides program-related articles, interviews, interactive activities, resources, and more.

Calendar FAQ
www.landfield.com/faqs/calendars/faq/part1/
This three-part article answers frequently asked questions about calendars and provides an overview of the Christian, Hebrew, and Islamic calendars in common use. It also provides a historical background for the Christian calendar, plus an overview of the French Revolutionary calendar, the Maya calendar, and the Chinese calendar.

The Maya Calendar
www.mayacalendar.com/mayacalendar/home.html
Includes links to many Maya-related sites, as well as illustrations of calendar glyphs and number symbols. Links offer routes to extend study into additional aspects of Maya life and culture.

Maya Calendar Tools
www.pauahtun.org/tools.html
Includes a number of Maya calendar conversion tools.

Program Contents

Fourteen years ago, NOVA began following seven Harvard Medical School students as they started a long and rigorous journey to become doctors. In three separate installments, NOVA follows the evolution of these seven as they progress from medical students to practitioners.

Tattooed Doctor:

- records Tom Tarter's work as an emergency room doctor addressing acutely ill people's immediate safety needs rather than being concerned with longer-term health management.
- conveys that, regardless of background, anyone with commitment and determination can become a doctor.

Second Opinions:

- chronicles internist Jane Liebschutz, ophthalmologist David Friedman, and former practicing pediatrician Cheryl Dorsey's earliest days in medical school.
- poses the ongoing question of whether these doctors would do it again and whether the singular dedication their training required was worth it.

Hearts and Minds:

- traces the medical school struggles of psychiatrist Jay Bonnar, anesthesiologist Elliott Bennett-Guerrero, and cardiologist Luanda Grazette.
- chronicles the different medical approaches and styles that these three doctors practice daily.

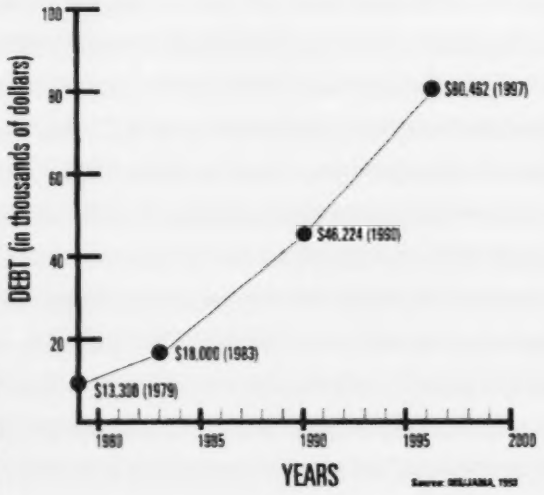
NOTE: These programs contain some graphic medical images. Please preview them to determine their appropriateness for students.

Before Watching

1. To begin, ask students if they ever considered medicine as a career choice. What attracts them to medicine? What kind of life, both professional and personal, do they believe a doctor has?

2. To help students understand what it is like to be a doctor, ask them to take notes as they watch, observing the different aspects of a life in medicine. What kind of hours do the doctors work? What kind of patients do they treat? Who do they interact with during the day? What skills do they use?

Average Debt for 4-Year Medical Education



After Watching

1. Have students review their notes about the different aspects of medical careers. Discuss their observations and consider the following questions. What seemed common among all the doctors? What varied by the specialty they were training for? Which aspects of their experience seemed to be most appealing? least appealing? What kind of personality traits would serve well in a medical career?

Activity Setup

Objective

To become acquainted with various medical careers.

Materials for each student

- copy of the *Who Does What?* activity sheets on pages 20–21
- copy of the *Who Does What? Answer Key* on page 22
- access to a dictionary or Internet

Procedure

1. Ask students what they know about careers in medicine. Have students brainstorm all the different medical jobs they know of, and list all suggestions on the board. Ask how many students would or have ever considered a medical career, and which one.
2. To help students become acquainted with the many types of jobs a medical career offers, give each student a copy of the *Who Does What?* activity sheet. It's likely that the sheet contains jobs the students have never heard of or considered.
3. Have students do the matching portion of the activity sheet. They may need to use the dictionary or the Internet to clarify the meanings of some medical terms, such as aneurysm, sinusitus, and catheterization.
4. Once everyone is finished, have students review all the careers on the list and choose the one that they think requires the most training and the one that requires the least.
5. Now provide students with the *Who Does What? Answer Key*. Have a discussion with students about the jobs they didn't know about. Which career descriptions were the biggest surprise?
6. Review with students the amount of training that each career requires. How accurate were students' predictions? Which career surprised them most in terms of its required study and practice?
7. To conclude the lesson, ask students again if they would consider a medical career. Did any students change their minds? If so, why? If not, why not?
8. As an *extension*, have students choose one of the medical careers that interests them most and do additional research on that career. What skills are required to be successful? What kind of lifestyle does the career offer in terms of work hours, compensation, and benefits?

Standards Connection

The activity found on pages 20–22 aligns with the following *National Science Education Standards*.

Grades 5-8

Science Standard G:
History and Nature of Science

Science as a human endeavor

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and the related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others.

Grades 9-12

Science Standard G:
History and Nature of Science

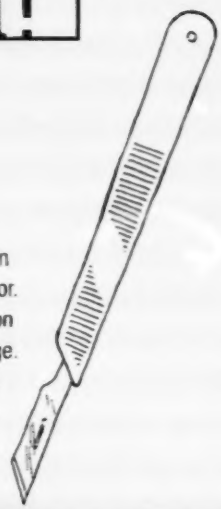
Science as a human endeavor

- Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Doing science or engineering can be as simple as an individual conducting field studies or as complex as hundreds of people working on a major scientific question or technological problem. Pursuing science as a career or as a hobby can be both fascinating and intellectually rewarding.

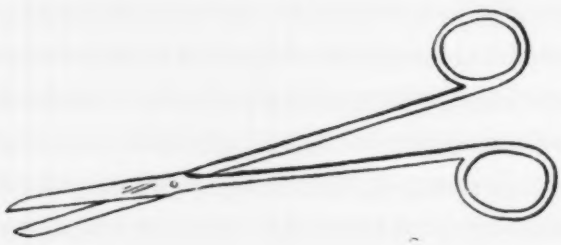
Who Does What?

NOVA Activity I **Survivor MD**

Who Does What?
Being a doctor is only one of many careers available in medicine. And there's more than just one kind of doctor. See if you can match the kind of health care profession with the right job description on the other activity page. Then see if you can choose which career requires the longest preparation, and which requires the shortest.



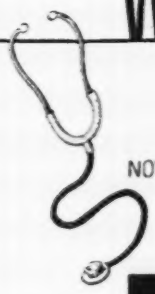
Profession	Answer	Profession	Answer
1 Dental hygienist		11 Forensic pathologist	
2 Ophthalmologist		12 Public health specialist	
3 Allergist/immunologist		13 Neurosurgeon	
4 Nurse practitioner		14 Hospice physician	
5 Cardiologist		15 Physical therapist	
6 Child psychiatrist		16 Radiology technician	
7 Dermatologist		17 Pharmacist	
8 Genetic counselor		18 Dietitian	
9 Emergency room doctor		19 Phlebotomist	
10 Internist		20 Registered nurse	



Questions
Write your answers on a separate sheet of paper.

1. When you have filled in all your answers, choose the career in the chart above that you think requires the most training and explain why.
2. Choose the career in the chart above that you think requires the least training and explain why.

Who Does What?



NOVA Activity | **Survivor MD**

Job Description	Job Description
A Uses ultrasound machines, magnetic resonance imagers, and other high-tech equipment to help diagnose and treat illnesses and injuries.	**K** Specializes in treating the largest and most visible of the body's organs. Examinations can focus on hair, nails, and mucous membranes.
B Focuses on restoring body movement. Cares for patients with chronic pain, with work- or sports-related injuries, with arthritis, or who are recovering from stroke.	**L** Supervises and plans the care of patients. Makes sure physicians' orders are followed. May give injections and administer fluids.
C Deals with the anatomy, functions, pathology and treatment of the eye.	**M** Manages overall patient health care and decides when to make referrals. Deals with simple things like heartburn to complex things like diagnosing cancer.
D Helps children and teenagers with psychiatric issues and conditions.	**N** Provides information and support to families who have members with birth defects or to individuals who may be at risk for a variety of inherited conditions.
E Evaluates aspects of health care delivery, promotes health and the prevention of disease, or focuses on health problems in developing countries.	**O** Draws blood from patients for testing purposes. Usually works under the supervision of medical technologists or laboratory managers.
F Treats conditions like sinusitis and asthma, and food intolerances.	**P** Integrates principles from biochemistry, physiology, and behavior to maintain patient health and assess risk related to diet and exercise.
G Performs physical exams, diagnoses and treats minor and chronic health conditions, and writes prescriptions.	**Q** Performs autopsies and plays Sherlock Holmes every day. Often called upon to testify in criminal investigations.
H Operates on the brain and the spine, and handles cases of brain aneurysms, and management of pain and movement disorders, among others.	**R** Deals with diseases like hypertension and coronary artery disease. Main role is to diagnose (using EKGs, stress echos, catheterizations) and treat conditions medically.
I Licensed to dispense drugs. Instructs people how to use medicine correctly. Deals with how and why drugs act the way they do and the implications of various drug treatments.	**S** Focuses primarily on prevention of oral diseases, treatment of conditions of the periodontium, and oral health education.
J Alleviates pain and suffering at the end of life. Coordinates team of social workers, nurses, and volunteers.	**T** Sees many types of patients; a day's cases might range from someone with painful swelling in the abdomen, to lacerations on the arm, to high fever with excessive vomiting, to difficulty breathing.

Who Does What? Answer Key

NOVA Activity | **Survivor MD**

Profession	Answer	Years of Training (After High School)	Profession	Answer	Years of Training (After High School)
Dental hygienist TOTAL = 2 years	S	Two years at a technical college studying dental hygiene for an associate's degree	**Forensic pathologist** TOTAL = 12 years	Q	Four years of medical school after college plus four years of training
Ophthalmologist TOTAL= 12 years	C	Four years of medical school after college plus four years of training	**Public health specialist** TOTAL = 9 years	E	Four years of medical or dental school after college and one year of training
Allergist/immunologist TOTAL = 13 years	F	Four years of medical school after college plus five years of training	**Neurosurgeon** TOTAL = 15 years	H	Four years of medical school after college plus seven years of additional training
Nurse practitioner TOTAL = 10 years	G	Four years of nursing school after college plus a two-year master's degree	**Hospice physician** TOTAL = 12–13 years	J	Four years of medical school after college plus four to five years of training
Cardiologist TOTAL = 14 years	R	Four years of medical school after college plus six years of training	**Physical therapist** TOTAL = 4–6 years	B	Minimum four-year college degree in physical therapy; some colleges offer an additional two-year master's degree; no medical school
Child psychiatrist TOTAL = 13 years	D	Four years of medical school after college plus five years of training	**Radiology technician** TOTAL = 2 years	A	Two-year training program after high school diploma or GED certificate is earned
Dermatologist TOTAL = 12 years	K	Four years of medical school after college plus one year of dermatology internship and three years of additional residency	**Pharmacist** TOTAL = 6 years	I	Six years of college study, typically at a college of pharmacy, resulting in a doctor of pharmacy degree
Genetic counselor TOTAL = 6 years	N	Four years of undergraduate study plus two years master's degree in genetic counseling	**Registered dietitian** TOTAL = 4+ years	P	Minimum of four years baccalaureate degree plus completion of a program in dietetics
Emergency room doctor TOTAL = 11–12 years	T	Four years of medical school after college plus three to four years of training	**Phlebotomist** TOTAL = 1–2 years	O	One to two years at vocational/technical school or community college
Internist TOTAL = 13 years	M	Four years of medical school after college plus five years of training	**Registered nurse** TOTAL = 2–4 years	L	Two-year or four-year college programs that are combined with clinical practice in hospitals; master's degree required to teach or specialize

Activity Answer

The descriptions provided for students represent only one focus of each discipline; like any other job, medical specialties include a variety of duties and responsibilities.

Medical specialists can also be found in a variety of locales, such as doctors' offices, hospitals, academic institutions, public health clinics, industrial plants, and relief agencies, among others. Medical careers also extend into the research realm, where scientists focus on learning how the body works or finding ways to combat disease.

The academic requirements listed are based on averages, more or less schooling may be required depending upon the extent to which a person specializes in a profession or the state requirements the person must meet. However, on average, the career that requires the most training is neurosurgeon (15 years) and the least training, a phlebotomist (1–2 years).

Resources

Books

Marion, Robert
Learning to Play God: The Coming of Age of a Young Doctor.
New York, NY: Fawcett Books, April 1993.
Draws from the author's experiences as medical student, intern, and resident to recreate the often brutal process of medical training.

Murray, John F.
Intensive Care: A Doctor's Journal.
Berkeley, CA: University of California Press, May 2000.
Recounts a month's events in the intensive care unit of San Francisco General Hospital. Murray, chief of the Pulmonary and Critical Care Division there, reveals the complexity and stress of a hospital unit's day-to-day operation.

Web Sites

NOVA Online—Survivor MD
www.pbs.org/nova/doctors/
Provides program-related articles, interviews, interactive activities, resources, and more.

Career Exploration
career.berkeley.edu/CareerExp/careerexpself.stm
Helps students evaluate career options with surveys that match personal interests, skills, values, temperament, and work style preferences with occupations.

Health Care Career Information
hmi.org/CHIS/career.html
Gives background on dozens of health care careers from chiropractor to midwife, and from veterinarian to psychologist. Links to a U.S. Department of Labor site called "Jobs for Kids Who Like Science."

Student Doctor Network's Big Guide to Medical School
www.studentdoctor.net/guide/index.html
Provides information specifically for high school students on why someone would consider being a doctor, on classes to take and grades to aim for, and on additional medical careers.

BEST COPY AVAILABLE

Cracking the Code of Life

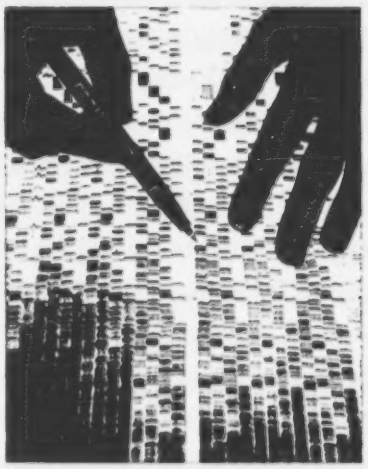
Airs the week of April 17 • www.pbs.org/nova/genome/

Program Contents

NOVA follows corporate and academic scientists as they race to capture one of the biggest prizes in scientific history: the complete, letter-by-letter sequence of genetic information that defines human life—the human genome.

The program:

- introduces Celera corporate scientist Craig Venter and MIT Whitehead Institute academic scientist Eric Lander, who runs one of the primary government-funded genome sequencing sites.
- explains Venter's breakthrough that isolated genes from "junk" DNA via high-speed computing and the use of short fragments of DNA called "expressed sequence tags".
- profiles the different research methods and styles of the academic and corporate scientists.
- reviews the debate and struggle over patenting genes.
- speculates on legal and ethical questions relating to use of the human genome.
- explains the structure and function of DNA, what a gene is and what it does, and how proteins—produced by genetic instruction—actually govern the body's processes.
- uses animation to depict how scientists "read" the genetic code and determine where genes are located.
- notes that almost every disease can trace its cause to some genetic mutation.
- provides examples of individuals and doctors who face health decisions that rest on information the human genome contains.
- summarizes that while mapping the human genome is one of the most significant achievements of the century, when finished, the project will really have just provided the infrastructure for years of future work in detecting, treating, and possibly curing human illnesses.



A scientist marks reference points on an autoradiogram that—through banding patterns—reveals base-pair sequences in DNA.

Before Watching

1. To help students understand terminology, review the concepts of and relationships among *DNA, genes, protein, chromosomes,* and *traits.* Stress that traits are the result of gene expression. Not all traits are visible to the eye (blood type, for instance) but some that students can see easily are hair color, eye color, and shape of face.

2. Help students make a connection between the word *mutation* and the physical change in a chemical base in the DNA molecule. Ask them to identify how the amino acid sequence would be changed if the triplet in the sequence, ACT, were changed to CAT.

After Watching

1. Sequencing the human genome may bring to light a number of genes that are the basis for known genetic diseases or that predispose a person to a condition such as heart disease, cancer, or Alzheimer's disease. Yet finding a gene for an illness may not lead to an immediate cure. Would students want to be tested to learn whether they had a genetic disease or predisposition if no cure was available? Why or why not?

2. Have students consider a scenario in which a lab needs DNA samples for use in genetic testing studies. Researchers are searching for a variant of a gene that provides resistance to specific bacterial diseases. If the company finds this gene, it may be able to produce a drug to sell to people who have these diseases. Would students agree to have their DNA be part of the study? Why or why not? Would they want royalties for their part in finding the gene? What if during the testing the company discovered they had a gene that might result in a health problem later in life? Would they want to be informed? Why or why not?

3. As more is learned about genes, there is a risk that the information will be used to define certain members of society by their genetic makeup. Ask students to identify the meaning of the terms genetic discrimination and genetic privacy. What are some ways to protect against this type of genetic discrimination?

When Talking About Genetics

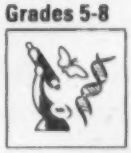
Some students may know of someone with a genetic disease. Try to be sensitive to students' feelings by using language that addresses the idea of genetic mutations, or variations, rather than pejorative terms like defective, or inadequate, genes. Let students know that everyone has mutations in their genetic makeup; not all of these are harmful. Some genetic variations are neutral and others are beneficial.

Standards Connection

The science activities on pages 28–31 and case studies on pages 32–33 align to the following *National Science Education Standards.*

Science Activities

Grades 5-8



Science Standard C:
Life Science—Reproduction and Heredity

Grades 9-12

Science Standard C:
Life Science—Molecular Basis of Heredity

Case Studies

Grades 5-8

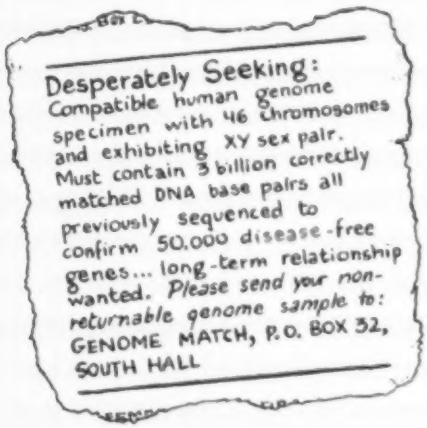
Science Standard F:
Science in Personal and Social Perspectives—Science and Technology in Society

Grades 9–12

Science Standard F:
Science in Personal and Social Perspectives—Science and Technology in Society

What Will the Future Bring?

Imagine this sign found on a bulletin board at a local school:


Desperately Seeking:
Compatible human genome specimen with 46 chromosomes and exhibiting XY sex pair. Must contain 3 billion correctly matched DNA base pairs all previously sequenced to confirm 50,000 disease-free genes... long-term relationship wanted. Please send your non-returnable genome sample to: GENOME MATCH, P.O. BOX 32, SOUTH HALL

Does this seems like an odd way to seek out a mate? It might be, but it would be one way to find out a great deal about someone. Everyone's genome provides a blueprint of their biological potential. It contains "directions" for the color of their eyes, of their hair (and whether they will have it when they are older), their projected height, even their potential for cancer, heart disease, or whether they may develop Parkinson's or Alzheimer's disease.

The human genome is found in each and every one of the many trillion of cells that make up the body. (See illustration, page 27.) Contained within these cells is a special structure called the cell nucleus. Coiled inside each nucleus are the 46 chromosomes a person inherits from her parents (23 each from the sperm and the egg). The parents, in turn, inherited their genes from their parents, and on back down the line to the very first cells that evolved. In each of the chromosomes is a molecule known as deoxyribonucleic acid (DNA). Containing a specific genetic code, the DNA molecule appears as a long chain of four distinct building blocks, or nucleotides. These nucleotides are abbreviated to four simple letters, A for adenine, and T for thymine, C for cytosine, and G for guanine.

While the sequence of letters is random in 97 percent of the 3 billion base pairs that comprise the genome, the remaining 3 percent contain the specific DNA nucleotide codes for making up a person. These letters form about 30,000 to 50,000 genes, each containing instructions for proteins, the major molecules that make up cells and tissues. The average-sized gene is 3,000 base pairs.

Initiated in the late 1980s, the Human Genome Project set out to identify the sequence of nucleotides (A, T, C, and G) in all the DNA that comprise a human being. Although people are more alike in their DNA than they are different—in fact, people are 99.9 percent alike—each person still contains a unique genetic code. In some instances, these coding differences are as simple as an alteration in one letter out of 1 million and have no impact on health. In others, these coding differences are the result of mutations that can cause genetic diseases such as cystic fibrosis or sickle cell anemia.

But big questions come with this genetic knowledge. What effect will mapping the genome have on people and society? Will this genetic information be used to discriminate against those with genetic predispositions? Will people decide to alter human traits, to pick and choose what they perceive as "normal" or "above average?" If prenatal screening reveals an embryo to have a predisposition to disease, what should the parents do? Who will govern how someone's personal genetic information is used?

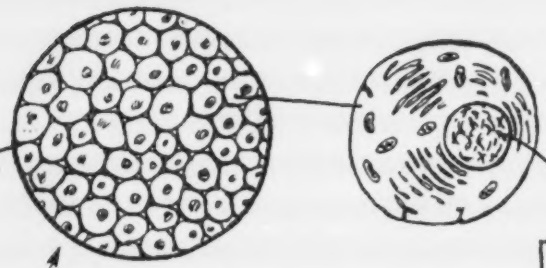
It is important to note that mapping the human genome is just the beginning. Knowing the sequence of the genome will help to identify genes, but scientists will then have to identify which genes are responsible for specific diseases. Even then, the diagnosis could be ambiguous; having a gene or genes does not always guarantee that someone will get a disease, just that the person might be predisposed to it.

The activities found in the following pages are designed to help students begin to understand the scientific principles and ethical, legal, and social issues behind the Human Genome Project.

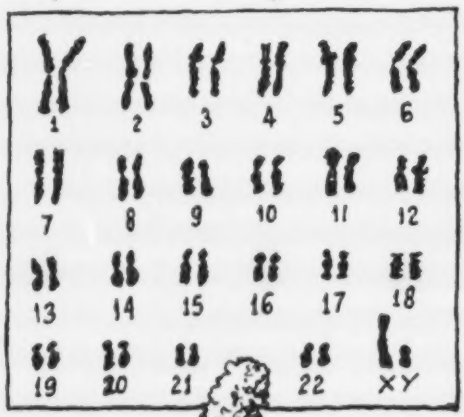
Contents **page**

Science Activities	28
Case Studies	32
Activity Answers	34
Resources	35

All of you—your bones, muscles, nerves, skin, and blood—is made up of **cells**. There are more than 10 trillion cells in your body.

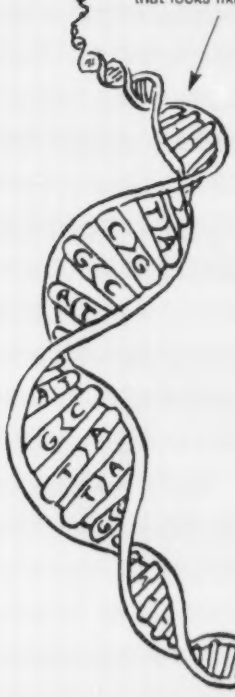


In the **nucleus** of almost every single cell are the complete instructions for making you. Those instructions are found in 23 pairs of **chromosomes**. This set of instructions is called your genome.

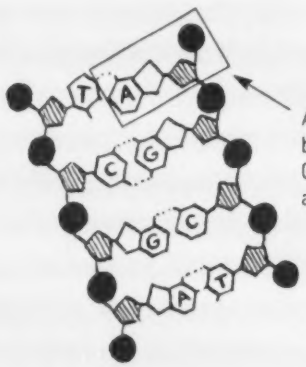


Each set of chromosomes—half of which come from your mother and half from your father—contains one tightly packed strand of **DNA**.

This DNA takes the form of a double helix that looks like a long, twisting ladder.



This ladder is made up of a series of letters—A, T, C, G—that represent the chemicals adenine, thymine, cytosine, and guanine. One pair of letters is called a **base pair**; a base pair is formed by the binding of two nucleotides. (A always pairs with T, and C always pairs with G.) A series of nucleotides, then, forms a **gene** that codes for a protein. Your genes produce thousands of different **proteins**.



A **nucleotide** contains a base molecule (A, T, C, or G), a sugar molecule, and a phosphate molecule.

Each strand of DNA may contain several thousand genes. Some genes are thousands of bases long; others are millions of bases long.

The goal of the human genome project is to determine the complete sequence of the human genome—to put 3 billion As, Ts, Cs, and Gs in correct order—and to locate its estimated 30,000 to 50,000 genes.

Activity Setup

Objective

To extract human DNA from cheek cells.

Materials for teacher

- slide of cheek cells stained with methylene blue

Materials for each student

- copy of the *See Your DNA* activity sheet on page 29
- 2 teaspoons (10 ml) 0.9 percent salt water (2 teaspoons table salt in one quart/liter of water)
- disposable paper or plastic cup
- large test tube (or any clear tube that can be sealed with a rubber or cork stopper)
- 1 teaspoon (5 ml) 25 percent mild detergent or dishwashing soap, e.g. Woolite or Palmolive (1 volume detergent or soap + 3 volumes water)
- 2 teaspoons (10 ml) 95 percent ethanol, chilled on ice
- small clear tube with seal

Procedure

1. If possible, before doing this activity, make and show a slide of some cheek cells and stain it with methylene blue so that students can see the shape of the nucleus of the cheek cell.
2. Provide each student with a copy of the *See Your DNA* activity sheet and a set of materials. Before students begin, make sure they understand and will follow guidelines for maintaining sterile conditions.
3. Have students prepare their saltwater and detergent solutions. When they are done, have each student swill two teaspoons of the saltwater solution in their mouths for 30 seconds. Make sure that students swish the solution around for the full 30 seconds. This will remove dead cells lining the mouth and provide students with a source of their own DNA.
4. Have students spit their solution into a disposable plastic cup and then pour it into a large test tube containing 1 teaspoon (5ml) of the detergent solution.
5. Students should cap the test tube and *gently* rock it on its side for 2–3 minutes. It is important that students are not too vigorous while mixing. DNA is an extremely long molecule. Physical abuse can break it into smaller fragments, a process known as shearing.
6. After gently rocking the solution, have students uncap the tube and then slightly tilt it and *carefully* pour 1 teaspoon (5ml) of the chilled ethanol down the inside of the tube so that it forms a layer on the top. Again, it is very important that the students take care in adding the ethanol so that the alcohol floats above the soapy solution already in the tube.
7. Tell students to allow the tube to stand for one minute. Then, have them use a thin acrylic or glass rod to slowly move some of the ethanol into the soap layer. The alcohol/soap interface is where most of the DNA will precipitate out of the soap solution. Have students twirl the rod to spool the DNA strands around it. If too much shearing has occurred, the DNA fragments may be too short to wind up, and they may form clumps instead. Students can try to scrape these out.
8. After students have wrapped as much DNA on the rod as they can, have them remove the rod and scrape or shake the DNA into a small tube with the remaining ethanol. Tell students that the DNA in their test tubes came from the nucleus of their cells, specifically, the 46 chromosomes in the nucleus.
9. Now that students have their DNA, what will they do with it? Will they grant consent for its use or keep it private from everyone? How will they guarantee this? Work with students to draft a policy statement concerning their own DNA.

Use of Ethanol

Closely supervise students' use of ethanol and instruct students that they cannot take the ethanol home.

See Your DNA

NOVA Activity | **Cracking the Code of Life**

DNA contains the instructions for making you. How you look, what blood type you have, even your tendency to get some diseases. It is found inside the nucleus in just about every single cell of your body. In this activity, you'll break away the membrane around the cell and its nucleus so that you can see your very own DNA.

Procedure

① This procedure will collect some of the buccal cells that line the inside of your mouth. These cells are continuously being sloughed off by your cheeks. Swill 2 teaspoons (10 ml) 0.9 percent salt water in your mouth for 30 seconds. This amount of swishing will actually become quite laborious—hang in there!

② Spit the water into your cup. Pour this into a large test tube containing 1 teaspoon (5 ml) 25 percent liquid detergent.

③ Cap tube and *gently* rock it on its side for 2–3 minutes. The detergent will break open the cell membrane to release the DNA into the soap solution. Do not be too vigorous while mixing! DNA is a very long molecule. Physical abuse can break it into smaller fragments, a process known as shearing.

④ Open and slightly tilt the tube and pour 1 teaspoon (5 ml) fluid ounces of the chilled 95 percent ethanol down the side of the tube so that it forms a layer on the top of your soapy solution.

⑤ Allow tube to stand for 1 minute.

⑥ Place a thin acrylic or glass rod into the tube.

⑦ Stir or twirl the rod in one direction to wind the DNA strands onto the rod. Be careful to minimize mixing of the ethanol and soapy layers. If too much shearing has occurred, the DNA fragments may be too short to wind up, and they may form clumps instead. You can try to scrape these out with the rod.

⑧ After you have wrapped as much DNA onto the rod as you can, remove the rod and scrape/shake the DNA into a small tube containing the rest of the 95 percent ethanol. Your DNA should stay solid in this solution.

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Activity Setup

Objective

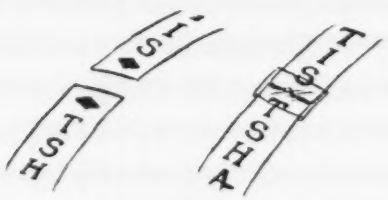
To help students understand the process involved in sequencing the human genome.

Materials for each group

- two sets of the *Mystery Message* activity sheet on page 31, cut in different locations
- scissors
- clear tape

Procedure

1. Before class, copy two sets of the *Mystery Message* activity sheet for each group. To prepare the sets for the activity, first cut out each column of letters. Next, attach them so that the symbol at the bottom of one column matches up with the symbol in adjacent column. Once the symbols are matched up, cut out the symbols and use clear tape to join the two pieces together so that there is no space in between the letters. Continue this until you have one long sequence.



2. Using a pair of scissors, cut the sequence of letters at four or five random locations. Do the same with the second sequence of letters, but *make sure* to cut the second sequence at different locations than the first. (You may want to laminate the cut pieces so you can use them again.)

3. Carefully fold and place the two sets of fragments of the message in a plastic bag. Organize students into groups and give one bag to each group.

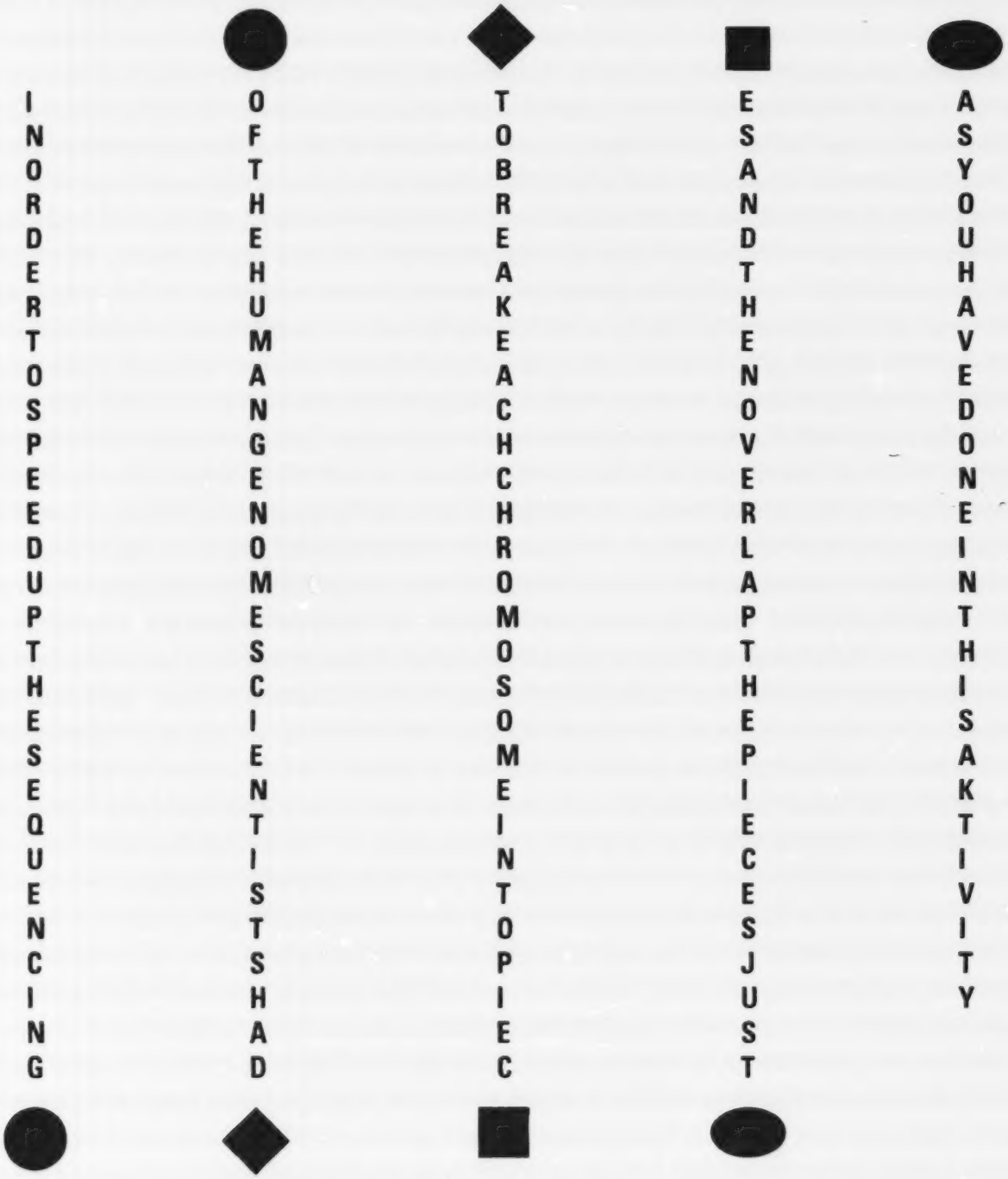
4. Tell students that to sequence the genome, scientists decided to cut up into small pieces all the chromosomes that make it up. These pieces, then, could be sent to different research teams to be sequenced, or decoded. These decoded pieces are represented in the cut-up series of letters in each group's bag.

5. Now comes the challenge: The genome needs to be put back together so that scientists can read the entire sequence. In each group's bag are all the pieces for one chromosome, but the group needs to figure out the original order.

6. Have students work to find a technique that will allow them to reconstruct the correct sequence of one chromosome. What was the content of the message? What else, if anything, did students note about the message?

Mystery Message

NOVA Activity | **Cracking the Code of Life**



Case Studies

NOVA Activity I **Cracking the Code of Life**

Patenting of Genes

Dr. Lydia Mendoza and her company, Genmania, have spent years working to identify how the gene for albinism works. The mutation in this gene causes no pigment to be produced in the hair, skin or eyes. Identifying the gene would open the door to curing the condition. Finally, her team succeeds.

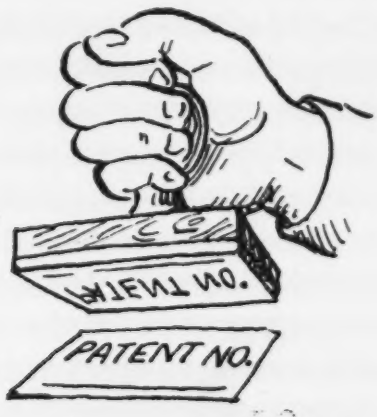
But the years spent on research were expensive. One way to make back that money is to patent the gene that team members just identified. Then, anyone who wanted to develop either treatments or tests would have to pay a fee to use the gene.

When a patent is submitted to the government, the company must prove that the item to be patented is original and patentable.

Questions

Write your answers on a separate sheet of paper.

1. What do you think about patenting a gene that already exists in the human body?
2. Should the government allow this gene to be patented? Why or why not?
3. Some think that genes should not be patented because they are a medical discovery and not an invention, and everyone should be allowed to use the information without paying. What do you think?
4. If, in the future, Genmania develops a test for this gene, should they be allowed to patent the test? Why or why not?



Therapy vs. Enhancement

Scientists in New Jersey have recently inserted a gene to create a mouse with increased capacity for learning and memory—basically, a gene that increased the animal's intelligence quotient (IQ).

Normal, average human IQ is about 100. Sometimes IQ can go way up to 130s, 140s, 150s, etc. An IQ of about 70 or below is considered to indicate mental disability.

Although currently highly theoretical and perhaps impossible, it might in the far future become possible to insert a human gene identified through the Human Genome Project to increase human IQ by 30 points. Consider these two scenarios:

- A couple has a 5-year-old son with Downs syndrome with an IQ of 70. They want to use gene therapy to insert a gene to increase the IQ of their son from 70 to 100 in order for him to function normally. This is considered gene therapy, where technology is used to help a person function better.
- A second couple has a 5-year-old son with an IQ of 120. They want to use the technology to bring their son's IQ up to 150. They feel he would then have a better chance to get accepted to a more prestigious university. This is called gene enhancement, where technology is used to help a person who is already at or above functioning levels to enhance a particular characteristic even more.

Questions

Write your answers on a separate sheet of paper.

1. Should gene technology be used for gene therapy? Why or why not?
2. Should gene technology be used for gene enhancement? Why or why not?
3. Who should decide? Parents? Doctors? Government? Society? Someone else?

Case Studies

NOVA Activity I **Cracking the Code of Life**

Newborn Screening

The Johnsons are married and their first child is just born. Marsha had a perfectly normal pregnancy and continued working until one week before the baby's birth. Al and Marsha's son appears, at birth, to be perfectly normal.

It is quite a surprise when the doctor calls them a few days after they take the baby home and asks them to bring him in for more tests. The doctor asks that both the mother and father come along because he wants to talk to them.

In his office the doctor says that a blood test was done while the baby was in the hospital as required by law. The test shows that the baby might have a genetic disease called phenylketonuria (PKU). However, more tests are needed to be sure. The Johnsons were told not to worry because there was a treatment for the condition. But neither Marsha nor Al has ever heard of the disease nor has anyone in their family.

Questions

Write your answers on a separate sheet of paper.

1. If all newborns are going to be screened, should parents have a chance to refuse? Why or why not?
2. If you were the Johnsons, what would you do next?
3. Should screening for diseases or defects be allowed when there is no cure or treatment? Why or why not?
4. Why might someone not want their child screened?
5. In the future, many more tests for genetic conditions will be available. Should we test all newborns for these, too? Why or why not?

Genetic Discrimination

Jonathon Jackson is 30 years old when his father dies of complications of Huntington's disease, a genetic condition that usually does not show up until a person is 35–40 years of age. Huntington's is characterized by a slow progression of physical and mental deterioration leading to death.

There is now a test available for the status of the Huntington's gene and Jonathon opts to be tested. Jonathon discovers he has the Huntington's mutation and faces a situation similar to his father's. This is called presymptomatic testing—checking for the presence of a harmful gene before any symptoms appear.

Somehow, Jonathon's health and life insurance companies learn about the results of his test and both cancel his protection. Then he is released from his job where he had worked faithfully for more than eight years. Company officials are afraid the medical costs of caring for his future medical complications will increase the group insurance rate.

Questions

Write your answers on a separate sheet of paper.

1. What would you do if you were Jonathon?
2. Should the company be allowed to make decisions based on medical information from Jonathon's DNA? Why or why not?
3. Should the company be able to make Jonathon's information available to other companies Jonathon is interviewing with? Why or why not?

Activity Answer

The Science of DNA

Activity 1—See Your DNA

DNA is only about 50 trillionths of an inch long. The reason it can be seen in this activity is because students are releasing DNA from a number of cells. This happens when the detergent or dishwashing liquid breaks, or lyses, the membranes around the cell and around the nucleus. Once released, the DNA from the broken open cells intertwines with DNA released from other cells. Eventually, enough DNA intertwines to become visible to the eye as whitish strands. Tell students that one strand of DNA is so thin they would never be able to see it without using a microscope.

Detergents break open cells by destroying the fatty membrane that encloses them. This releases the cell contents, including DNA, into the solution. Detergents also help strip away proteins that may be associated with the DNA.

DNA is not soluble at high ethanol concentrations, so it precipitates out as long strands. Salts, such as sodium chloride, also greatly aid in precipitating DNA. The ethanol also causes gases dissolved in the water to be released, which may be observed as small bubbles.

This procedure may not work well if the researcher has eaten corn flakes for breakfast. Presumably this is because the corn flakes have scoured too many buccal cells from the inside of the mouth. Repeating may give low yields if most of the loose buccal cells have already been harvested.

Activity 2—Mystery Message

In mapping the DNA sequence on a chromosome, scientists have found it faster to divide and conquer. The 24 chromosomes in the human genome (22 autosomes and the X and Y) are cut into many smaller fragments. Each fragment is sent to a different research lab to be sequenced. When the sequencing of these smaller fragments is completed, a computer is used to find the overlapping regions and put them into the correct order as found on the intact chromosome.

By overlapping sequences of letters, students should be able to arrive at the secret message coded on the original strip. The final message reads: "In order to speed up the sequencing of the human genome scientists had to break each chromosome into pieces and then overlap the pieces just as you have done in this aktivity"

Some students may notice that the final word in the sentence, aktivity, is misspelled. Explain to students that this represents a base-pair, or one-letter, mutation in the chromosome. Even a single base-pair mutation can cause a genetic illness.

Case Studies

Ethical issues deal with what is moral or right. Legal issues address laws or regulations that may be set up to protect society members. And social issues look at how society and its individuals will be affected by certain decisions.

There are no right or wrong answers when societal issues are debated, but rather many different opinions about what is best ethically, legally, and socially. Talking about genetics can be emotional for students. Be sensitive to students' answers. Be sure to consider all points of view.

Resources

Books

Baker, Catherine.
Your Genes, Your Choices: Exploring the Issues Raised by Genetic Research.
Washington, D.C.: AAAS, 1999.
Describes the Human Genome Project, the science behind it, and the ethical, legal, and social issues raised by the project.

Marshall, Elizabeth L.
The Human Genome Project : Cracking the Code Within Us.
Minneapolis, MN: Econo-Clad Books, 1999.
Explores the process and technology used in sequencing a portion of the human genome. A chance to see the process of science through the eyes of the scientist. The author connects the discoveries in the human genome with the ethical implications they pose for society.

Reilly, Philip R.
Abraham Lincoln's DNA and Other Adventures in Genetics.
Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, August 2000.
Offers wide-ranging tales of crime, history, illness, and ethics to illustrate principles and issues of human genetics.

Sayre, Anne.
Rosalind Franklin and DNA.
New York, NY: W. W. Norton & Company, Inc., July 2000.
Offers a true life account of Franklin's work in elucidating the structure of DNA and explores the difficulties often faced by women in science. Franklin's research was central to the Nobel Prize-winning discovery of DNA, and Watson and Crick's discovery relied heavily on her pivotal X-ray crystallography data.

Watson, James D.
The Double Helix: A Personal Account of the Discovery of the Structure of DNA.
New York, NY: Simon & Schuster, 1998.
Chronicles the original story behind the race to discover the structure of DNA as seen through the eyes of James Watson.

Articles

Crick, Francis and James Watson.
"A Structure of Deoxyribonucleic Acid."
Nature. Volume 171. 1953, Pages 737–738.
The seminal paper on the discovery of the structure of DNA.

"Outlook 2000: Inventing the Future."
U.S. News & World Report,
January 3, 2000.
Special double issue includes different articles about the Human Genome Project, which explain how the secrets of DNA may help cure illnesses and arrest aging, as well as outline the benefits and perils of genetic testing.

Web Sites

NOVA Online—Cracking the Code of Life
www.pbs.org/nova/genome/
Provides program-related articles, interviews, interactive activities, resources, and more.

Genes and Disease
www.ncbi.nlm.nih.gov/disease/
Shows what diseases have been mapped on which chromosomes. The Map Viewer presents a graphical view of the available human genome sequence data as well as cytogenetics, genetic, physical, and radiation hybrid maps.

The Human Genome Project
www.nhgri.nih.gov/HGP/
Provides background information on the Human Genome Project from the National Human Genome Research Institute. Several links provide more detailed resources describing the history and goals of the Human Genome Project.

Genetics Resources
www.library.vcu.edu/tml/bibs/genetics.html
Offers list of links with descriptions to more specific subject areas in the topic of genetics and medicine.

Genetically Modified Foods

Airs the week of April 24 • www.pbs.org/wgbh/gmfoods/

Program Contents

What are the arguments for and against genetically engineered foods? Join NOVA and FRONTLINE as they track the debate and explore the issues.

The program:

- explains how scientists use genetic engineering to isolate a specific gene from one organism and insert it into another, possibly unrelated, organism.
- provides examples of benefits of this technique, including engineering plants that can survive being sprayed by weedkiller or can create their own pest defenses.
- introduces opposition that states there is no way to predict with complete certainty what effects these genetically engineered plants may have on the environment.
- presents concerns that genes from an engineered plant could spawn superweeds and superbugs.
- reviews the practice of planting a 10 percent "refuge" around crops in which insects can reside.
- speculates on fear that proteins produced by inserted genes might be dangerous, either because the proteins themselves are allergenic or because they might alter the plant's chemistry, making it toxic.
- examines the need for genetically engineered foods, including the claim that these foods will help reduce starvation and improve nutrition in developing countries.

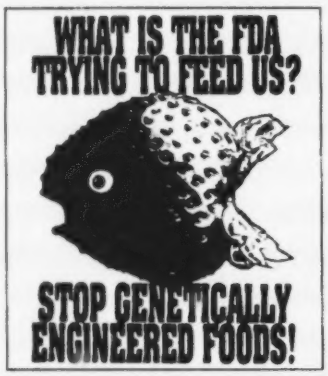
NOTE: The use of the term genetically modified foods in this lesson refers to foods that have been modified via genetic engineering.

Before Watching

1. Review with students the difference between traditional plant breeding and breeding done through genetic engineering. *(Traditional breeding involves exchanging all genetic material from two related plants; genetic engineering usually only involves moving one or two genes but can cross the species barrier.)*

2. Explore with students what they already know about genetically modified foods. Has anyone knowingly eaten them? (See *Activity Answer* on page 39 for examples of genetically modified foods.) If students knew a food was the product of genetic engineering would they eat it? Why or why not?

3. Divide the class into two groups. As they watch, have one group keep track of the arguments for genetically modified foods, and another group record the arguments against.



Sign at a rally to ban the production of genetically engineered foods.

After Watching

1. Have students review and discuss the arguments they noted for and against genetically modified foods.

2. Proponents for genetic engineering suggest it will help end world hunger. Have students research and define areas of the world most affected by starvation. What populations are hardest hit? What kind of land do they have available for farming? What role, if any, could genetic engineering play in making that land useable? What are reasons for and against proposing genetic engineering as a solution?

Activity Setup

Objective

To research and debate the arguments for and against the use of genetically modified foods.

Materials for each group

- copies of *Are Genetically Modified Foods Safe?* activity sheet on page 38
- access to print and Internet resources

Procedure

1. The issues of the safety of and need for genetically modified foods are being hotly debated in the United States, Europe, and other countries. To help students understand this complex issue, tell them they have been appointed to brief a special Food and Drug Administration review board about the pros and cons of genetically modified foods.

2. The board wants to know:
   - all the arguments for allowing the use of genetically modified foods.
   - all the arguments against the use of genetically modified foods.
   - the potential risks and benefits of genetically modified foods.
   - what plants or foods have been allowed or banned in which countries, and why.
   - how these foods are different, and how they are the same, as other products currently being sold.
   - whether foods should be allowed if they are labeled, and why.
   - whether some foods should be allowed but not others, and why.

3. Organize students into groups, based on whether they took notes for or against the use of genetically modified foods. Give each group a copy of the *Are Genetically Modified Foods Safe?* activity sheet.

4. Have students use their notes from the program and additional resources to form their arguments. Once students are finished researching, have them present their findings and final recommendations to the board.

5. When the debates are over, hold a class discussion about whether students would be willing to eat genetically modified foods and why or why not. To conclude the lesson, have students discuss how the decision whether to allow these foods to be grown should be made and who should be part of the decision-making process.

6. As an *extension*, have students survey their peers and adults about foods from genetically modified foods. Why would or wouldn't other people eat them? What are their responses based on?

Standards Connection

The activity found on page 38 aligns with the following *National Science Education Standards*.

Grades 5-8

Science Standard F:
Science in Personal and Social Perspectives

Risks and benefits

- Individuals can use a systematic approach to thinking about risks and benefits. Examples include applying probability estimates to risks and comparing them to estimated personal and social benefits.
- Important personal and social decisions are made based on perceptions of benefits and risks.

Grades 9-12

Science Standard F:
Science in Personal and Social Perspectives

Personal and community health

- Personal choice concerning fitness and health involves multiple factors. Personal goals, peer and social pressures, ethnic and religious beliefs, and understanding of biological consequences can all influence decisions about health practices.

Are Genetically Modified Foods Safe?

NOVA Activity I **Genetically Modified Foods**

Foods resulting from genetically modified plants have already been introduced into the food supply in some countries, including the United States and those in Europe. But not everyone thinks these foods are safe. You've been appointed to research and report to a special Food and Drug Administration board about these foods. Find out all you can and then decided for yourself: Are genetically modified foods safe?

Procedure

Create a table like the one below on a separate sheet of paper.

1. Circle whether your group is researching the arguments FOR or AGAINST the use of genetically modified foods.
2. Use additional resources to find out more information about these foods.
3. Consider the following as you do your research:
   - all the arguments for or against the use of genetically modified foods.
   - the potential risks and benefits of genetically modified foods.
   - what plants or foods have been allowed or banned in which countries, and why.
   - how these foods are different, and how they are the same, as other products currently being sold.
   - whether foods should be allowed if they are labeled, and why.
   - whether some foods should be allowed but not others, and why.

Questions

Write your answers on a separate sheet of paper.

1. What foods have been allowed or banned in which countries? Why?
2. Why should foods be allowed if they are labeled? Should labeling be mandatory or voluntary?
3. Should some foods be allowed but not others? If so, which ones and why?

Names of group members:
Our group is arguing FOR/AGAINST the use of genetically modified foods.
Reason 1:
Reason 2:
Reason 3:

Activity Answer

Currently, most genetically modified foods have been agricultural crops (as shown in the chart below). In addition to crops, some U.S. companies have begun research into genetically modifying fish, including salmon, bass, catfish, and trout. Although some crops and seafood have undergone mandatory or voluntary review by regulatory agencies such as the U.S. Department of Agriculture, the Environmental Protection Agency, and the Food and Drug Administration, none of these products are currently required by the U.S. government to be labeled as being genetically modified.

Other countries that have approved biotech varieties for commercial production include Germany, Switzerland, Canada, China, Argentina, South Africa, and Japan.

Students most certainly have already eaten genetically modified foods without knowing it. Using the program and other resources, students should be able to list and defend arguments for and against the use of genetically modified foods.

Genetically Engineered Crops
This list, drawn from the Union of Concerned Scientists' Web site **(www.ucsusa.org/)**, provides only a few examples of genetically engineered crops and reasons for modifications.

Product	Engineered Trait(s)	Source of New Genes
canola	resists herbicide	bacteria, virus
chicory (radicchio)	makes male sterile to facilitate hybridization	bacteria
corn	expresses Bt toxin to control insect pests	bacteria
cotton	resists herbicide	tobacco, bacteria
flax	resists herbicide	arabidopsis, bacteria
papaya	resist papaya ringspot virus	bacteria, virus
potato	expresses Bt toxin to control insect pests	bacteria, virus
soybean	alters oil to increase stability and reduces polyunsaturated fatty acids	soybean, bean, bacteria, virus
squash	resists viruses	bacteria, virus
sugarbeet	resists viruses	bacteria, virus
tomato	alters ripening to enhance fresh market value	bacteria, virus

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Resources

Book
McHughen, Alan.
Pandora's Picnic Basket: The Potential and Hazards of Genetically Modified Foods.
London: Oxford University Press, October 2000.
Examines some of the basic scientific issues involved in whether genetic modification may turn out to yield harmful or, conversely, beneficial results.

Articles
Glausiusz, Josie.
"The Great Gene Escape."
Discover, May 1998, 90–97.
Explains the promise and criticisms of transgenic food production.

"Seeds of Change."
Consumer Reports, September 1999, 41–46.
Explains the promise and criticisms of transgenic food production.

Specter, Michael.
"The Pharmageddon Riddle: Did Monsanto just want more profits, or did it want to save the world?"
The New Yorker, April 10, 2000, 58–71.
Describes the biotechnology firm, Monsanto, and its influence on agriculture, particularly with its development of genetically modified products.

Web Sites
NOVA Online—Genetically Modified Foods
www.pbs.org/wgbh/gmfoods/
Provides program-related articles, interviews, interactive activities, resources, and more.

Biotechnology Industry Organization
www.bio.org/about.html
Offers the industry's position on food and agricultural biotechnology. Includes discussion on food labeling, government regulation information, and lists products on or coming to market.

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NOVA Video Catalog

Now two ways to save!

Save 15%** on orders of 3 videos or more

Save 25%** on orders of 10 videos or more

**not including shipping & handling

This is not a complete listing of NOVA videos. Please call 1-800-949-8670 ext. 0300 for a free catalog.

These videos have been categorized by their primary content strand; many programs are interdisciplinary. You may want to scan several categories for videos of interest.

Special Savings

Special! For Educators Only!

Receive a special set of the new *NOVA* videos featured in this Spring 2001 Teacher's Guide for only $84.95 plus shipping and handling. Set includes: *Sultan's Lost Treasure, Vanished!, Lost King of the Maya, Survivor MD,* and *Cracking the Code of Life.* 8 hrs. on 6 cassettes. Educational use only. **WG1145** *Available May 2001.*

Earth & Space Science

Adrift on the Gulf Stream

Explore the Stream's importance to ocean life, climate and human history. Writer Bill MacLeish travels its full course, sailing on top of it, diving under it and viewing its mighty swirl via satellites in space.
Educational use only. 1 hr. **WG1606* $19.95**

Apollo 13: To the Edge and Back

The gripping, true story of the catastrophic flight of the Apollo 13 and the heroic struggle to bring the astronauts back alive. With first-hand accounts from the pilots, their families and the people of mission control, it documents a thrilling struggle against time and all odds and serves as a reminder that, in the words of James Lovell, "We do not realize what we have on Earth until we leave it."
Educational use only. 1.5 hrs. **WG514 $19.95**

Avalanche!

With no warning and in mere seconds, avalanches wipe out everything in their paths, killing hundreds of people each year. Put yourself in the path of this terrifying force from the ski slopes of Montana to a village in Iceland, from Juneau, Alaska, to Switzerland's mountain roads—and see what risks scientists are taking to protect us.
1 hr. **WG2418N $19.95**

Buried in Ash

Learn what life was like ten million years ago when a volcanic eruption buried much of what is now Nebraska in up to ten feet of ash.
1 hr. **WG2117* $19.95**

Chasing El Niño!

Lethal ice storms, droughts, floods and devastation—what in the world is going on here? *NOVA* explores the myths, reveals the devastation, explains the fascinating facts and provides a new climate for understanding the ultimate weather machine.
1 hr. **WG2512 $19.95**

Cracking the Ice Age

The Himalayas, towering over the Tibetan plateau, are one of the world's most magnificent sights. But could they also be the cause of one of the planet's most dramatic climatic changes—the Ice Age? Take a trek to Tibet with a renegade band of researchers bent on proving this controversial concept. *Educational use only.*
1 hr. WG2320* $19.95

Daredevils of the Sky

Strap in for a ride with America's greatest stunt pilots! Stunning in-air photography puts you in the pilot's seat with the U.S. Aerobatic Team.
1 hr. **WGW2103 $19.95**

Deadly Shadow of Vesuvius

Scientists believe it's only a matter of time before Italy's Vesuvius erupts...again. Find out how science can help predict when Vesuvius will change from dormant to destructive.
1 hr. **WG2515 $19.95**

The Doomsday Asteroid

Join the hunt to scan the skies and earth for evidence that giant rocks from outer space have struck before and will strike again. *Educational use only.* 1 hr. **WGD2212* $19.95**

Earthquake

Predicting earthquakes is risky business, but *Earthquake* shows how today's advanced technology helps geologists interpret nature's rumblings. 1 hr. **WG1715* $19.95**

Eclipse of the Century

The race to view and study celestial splendor.
1 hr. **WG1910 $19.95**

Faster Than Sound

The international race to build an aircraft that could crack the sound barrier was fraught with danger, ambition and intrigue. *NOVA* tells the real story of those who risked all to make aviation history—including Chuck Yeager, who on October 14, 1947 was the first pilot to fly faster than sound.
1 hr. **WG2412 $19.95**

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WGBH BOSTON VIDEO

Flood!

Relive one of the greatest flood disasters—the Mississippi River in the summer of 1993—and explore the problem of taming the mightiest river. 1 hr. **WG2307 $19.95**

Hawaii Born of Fire

Behold the fiery moonscapes and lush rain forests surrounding Hawaii's active volcanoes. *Educational use only.* 1 hr. **WGH2211* $19.95**

Hunt for Alien Worlds

All eyes are on the heavens in search of planets around other stars, probably the best hope for showing that we may not be alone in the universe. *NOVA* covers an effort that is turning up more and more new worlds. *Educational use only.* 1 hr. **WG2407* $19.95**

Journey to the Sacred Sea

Travel to Lake Baikal, the world's oldest and deepest lake, containing one-fifth of all the fresh water on Earth. Investigating Baikal from above, below and all around, *NOVA* charts its dramatically changing environment over the course of four seasons.
Educational use only. 1 hr. **WG2119* $19.95**

Natural Disasters Boxed Set

Natural disasters strike with little or no warning—making them uniquely frightening and fascinating. Includes *The Day the Earth Shook, Tornado!,* and *In the Path of a Killer Volcano.* 3 hrs. on 3 cassettes **WG165 $49.95**

Nature's Fury Boxed Set

Witness the awesome power of nature. Includes *Hurricane!, Lightning!* and *Killer Quake!.* 3 hrs. on 3 cassettes **WG027 $49.95**

Runaway Universe

With the use of stunning three-dimensional cosmic simulations captured with revolutionary high-definition technology, *NOVA* presents the first attempt to explore the riddle of "dark energy"—the mysterious repulsive force that some scientists believe counteracts gravity. *Runaway Universe* presents the dramatic quest to unlock secrets of the stars as two rival teams search for exploding stars, map gigantic cosmic patterns of galaxies, and grapple with the ultimate question: what is the fate of the universe?
1 hr. **WG2713 $19.95**

Space Explorers Boxed Set

Step on the moon. Float in space. Explore the final frontier. *NOVA* assembles three of its most acclaimed space adventures to create this special four-hour set. Includes *To the Moon, Terror in Space* and *Rescue Mission in Space.* 4 hrs. on 3 cassettes.
WG567 $49.95

Stationed in the Stars

Go inside the planning, assembly and excitement of history's most ambitious and expensive engineering venture—a hugely ambitious "orbiting city" set for completion in 2004.
Educational use only. 1 hr. **WG2708 $19.95**

Supersonic Spies

This true tale of Cold War espionage reveals what really happened at the 1973 Paris air show, a supersonic competition between Soviet and French planes, when the Konkordski went down in a fatal, fiery explosion, never fully explained by either the French or Soviets.
1 hr. **WG2503 $19.95**

To The Moon

This expanded two-hour special shares vivid recollections of Apollo astronauts Gene Cernan and Frank Borman, and introduces you to legendary Flight Director Gene Kranz and other unsung heroes of the entire space program. Rare interviews and amazing footage capture America's full-thrust effort to be the first to the moon.
2 hrs. **WG2610 $19.95**
NEW! DVD 2 hrs. **WG998 $19.95**

Top Gun Over Moscow

For half a century we feared them. Now, for the first time, meet the rugged pilots of the Russian Air Force—and take a close-up look at the heart-stopping maneuvers that still fill Western flyers with awe. 1 hr. **WG2315 $19.95**

Volcanoes of the Deep

The pitch-black, near-freezing water nearly 8,000 feet below the ocean surface is the last place you'd suspect life to flourish. But here sea life thrives on mammoth superheated volcanic chimneys. Is the key to life's origins locked inside their fiery cores? 1 hr. **WG2609 $19.95**

Warnings from the Ice

Huge ice sheets in Antarctica may be in the process of collapse, triggering a catastrophic rise in sea level that will inundate the most populous regions of the world. Join *NOVA* as they gather data that will reveal new insight into the nature of global climate change.
1 hr. **WG2508 $19.95**

What's Up with the Weather?

In this special two-hour program, *FRONTLINE* and *NOVA* take on one of the most complex and important challenges facing the world today—global warming. Take a dramatic journey to find out what's in store for our Earth's climate system.
2 hrs. **WG904 $19.95**

General Science

Anastasia Dead or Alive?

Investigate the massacre of Tsar Nicholas and his family, and evaluate whether modern science has resolved the mystery surrounding Princess Anastasia. 1 hr. **WGA2209 $19.95**

B-29 Frozen in Time

Join a grueling expedition to recover this rare plane from the North Pole after 50 years—a trip which tests team members in ways they never imagined. 1 hr. **WG2303 $19.95**

The Beast of Loch Ness

Is the Loch Ness Monster a hoax? Join *NOVA* for an all-out investigation of the mystery as scientists scour the loch with sonar and the most famous photo of Nessie is put to the test.
1 hr. **WG2601 $19.95**

The Bermuda Triangle

An investigation of the mysterious watery graveyard in the Atlantic. 1 hr.
WGW264 $19.95

Building Big with David Macaulay Boxed Set

Award-winning author-illustrator—and captivating storyteller—David Macaulay (*The Way Things Work*) goes to extremes in five really big adventures exploring the fascinating facts behind the greatest manmade wonders of the world. Includes *Bridges, Domes, Skyscrapers, Dams,* and *Tunnels.*
5 hrs. on 5 cassettes **WG965 $69.95**

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Building Big with David Macaulay Educational Curriculum

Explore large structures and what it takes to build them with this new five-part series. Hosted by David Macaulay, the award-winning author and illustrator of *The Way Things Work* and other books, each one-hour program focuses on a type of construction integral to modern life: bridges, tunnels, dams, skyscrapers, and domes. Discover the stories behind famous structures and their builders, plus how engineers today are building bigger than ever before. Each video also includes a short vignette featuring kids doing a simple hands-on engineering activity. Educators can easily re-create these activities using the printed instructions that are included. Also included is a short video for middle-school students that explores a key theme from the series, and a 40-page, full color activity guide.
6 hours on 6 cassettes **WG982 $99.95**

Decoding Nazi Secrets

Historic, fascinating and filled with stunning revelations, *NOVA* presents the first fully detailed account of the greatest codebreaking coup of all time. In this two-hour special, hear American and British codebreakers reveal long-held secrets for the first time. 2 hrs. **WG2615 $19.95**

The Diamond Deception

What takes nature billions of years, man is doing now in a few days—creating flawless diamonds. *Educational use only.* 1 hr. **WG2703 $19.95**

ESCAPE! Because Accidents Happen Boxed Set

In the air, at sea, on the road, or in your home, you must be prepared to escape! *NOVA* goes behind the sensational headlines to examine the fascinating science of "survival engineering." Includes *Fire, Car Crash, Plane Crash* and *Abandon Ship.* 4 hrs. on 4 cassettes **WG260 $49.95**

Everest: The Death Zone

Climb all the way from Base Camp to the very pinnacle of the earth at 29,028 feet. You'll witness first-hand why rational people can make astonishingly poor, and sometimes fatal decisions, on the world's highest peak. Narrated by Jodie Foster. By David Breashears, the Emmy® award-winning producer of the IMAX film.
1 hr. **WG2506 $19.95**
DVD 1 hr. **WG800 $19.95**

Everest: The Mystery of Mallory and Irvine

Did George Mallory and Andrew Irvine reach the top of Mt. Everest in 1924, nearly 30 years before Sir Edmund Hillary and Tenzing Norgay? This award-winning film, produced by renowned climbers and filmmakers David Breashears and Andrew Harvard, takes a fascinating look at Mallory's courageous attempt and the enduring mystery surrounding his disappearance.
1 hr. **WG830 $19.95**

Fall of the Leaning Tower

Tilting at an amazingly dangerous angle, the Leaning Tower's problem is obvious—its solution isn't. See how science is attempting to save a medieval masterpiece with a high-risk rescue plan that may add centuries to the life of this architectural treasure. 1 hr. **WG2611 $19.95**

Hitler's Lost Sub

In 1991, a German U-boat wreck was discovered off the New Jersey coast. But neither the US, British *or* German military knew its identity until two divers and their dedicated team spent six long years searching for clues in the rusty remains. *Hitler's Lost Sub* embarks on a fascinating two-hour journey that traces submarine and World War II history, dives 230 feet into the ocean for a deep sea detective adventure, and travels to Germany to correct a significant part of military history. 2 hrs. **WG2712 $19.95**

Holocaust On Trial

British historian and author David Irving claims the Holocaust was a myth—that Hitler never mandated mass extermination of the Jews. Facing a charge of libel, Irving defended himself in the British court system in early 2000 against American scholar Deborah Lipstadt. *Holocaust On Trial* reconstructs the charged and dramatic courtroom proceedings as Irving defends himself and Hitler's Nazi atrocities. Haunting, unsettling, moving and enlightening, this film traces the rise of the Third Reich's Final Solution, recounts its unimaginable horrors through devastating and rare footage and explains the motives of those who continue to deny this atrocious history.
Educational use only 1 hr. **WG2711 $19.95**

Hunt for Alien Worlds

All eyes are on the heavens in the search for planets around other stars, probably the best hope for finding that we are not alone in the universe. *NOVA* covers an effort that is turning up more and more new worlds.
Educational use only. 1 hr. **WG2407* $19.95**

Ice Mummies Boxed Set

You're there as the ice mummies are unearthed, as clothing and artifacts are studied, and as mysteries of the Stone Age are explained. Includes *Frozen in Heaven, Siberian Ice Maiden* and *Return of the Iceman.*
3 hrs. on 3 cassettes **WG2525 $49.95**

In Search of Human Origins Boxed Set

The award-winning exploration of the beginnings and expansion of the human race. Includes *The Story of Lucy, Surviving in Africa* and *The Creative Revolution.*
3 hrs. on 3 cassettes **WGW2111 $49.95**

In Search of the First Language

NOVA explores the common threads that link the more than 5,000 languages of Earth. Educational use only. 1 hr. **WG2120* $19.95**

Kidnapped by UFOs

Meet the ordinary Americans who claim to have been kidnapped by UFOs and the experts who are researching their stories.
1hr. **WG2306 $19.95**

The Killer's Trail

Did Dr. Sam Sheppard kill his wife? With the help of advanced technology, *NOVA* re-examines the 1954 murder of Marilyn Sheppard and the subsequent trials of her husband. America's most intriguing unsolved murder reveals fascinating new clues...and surprising new suspects. 1 hr. **WG2613 $19.95**

Lincoln's Secret Weapon

After four hours at near point-blank range, The Union's warship the *USS Monitor* battled the Confederacy's well-armored *CSS Virginia* to a draw, altering—in one morning—the course of the Civil War and naval combat. After serving less than 12 months on active duty, the Monitor sank in 230 feet of water off North Carolina's Cape Hatteras. Join an elite team of Navy divers attempting to retrieve priceless artifacts of naval history and discover the well-preserved secrets of the Monitor's short-but-significant military service. 1 hr. **WG2710 $19.95**

*No Retail Packaging

Lost at Sea: The Search for Longitude

Richard Dreyfuss narrates this riveting story of an ingenious country carpenter who discovered that the secret to navigation lay not just in the stars but in the mastering of time. Climb aboard an authentic tall ship and go back in time to see the quest for longitude unfold.
1 hr. **WG2511 $19.95**

NEW! Lost King of the Maya

For 400 years, the Yax K'uk Mo's dynasty of Holy Lords presided over the Mayan city of Copan, maintaining power through hallucinogenic vision quests, ritual warfare, and human sacrifice. Generations of scholars have dismissed the story of Yax K'uk Mo as pure myth. But now, a team of archaeologists has dug 130 feet underground and over 1500 years back in time and may have found his tomb. Will these archaeologists' discoveries transform the legend of Yax K'uk Mo from myth into reality?
1hr. **WG2804 $19.95**

Lost On Everest

The discovery of mountain-climbing pioneer George Mallory's body on Mt. Everest in May 1999 reveals new clues to his final hours and mountaineering's most haunting mystery. 1 hr. **WG2702 $19.95**

Lost Tribes of Israel

Nearly 3,000 years after their banishment, *NOVA* dispels both myth and fantasy in a dramatic genealogical quest that uses DNA evidence in the search for alleged descendents of Israel's Lost Tribes. 1 hr. **WG2706 $19.95**

A Man, A Plan, A Canal, Panama

Explore the mind-boggling construction of the Panama Canal through historic film footage, rare archival photographs and insightful narration from author-historian David McCullough. Get an unprecedented look at the people behind the Canal's deadly 30-year construction and witness its amazing present-day operation.
1 hr. **WG1415 $19.95**

Mystery of the First Americans

NOVA uncovers the astonishing history and explains the current Native American controversy over Kennewick Man—a 10,000-year-old Caucasoid discovered near Washington's Columbia River in 1996. 1 hr. **WG2705 $19.95**

Mysterious Mummies of China

Perfectly preserved 3,000-year-old mummies have been unearthed in a remote Chinese desert shedding new light on the contact between the East and West in the ancient world. But these don't appear to be the ancestors of the modern-day Chinese people—they have long, blonde hair and blue eyes. 1 hr. **WG2502 $19.95**

NEW! Nazi Prison Escape

Colditz Castle in eastern Germany was the ultimate escape-proof prison of World War II, yet from 1940 to 1945, over 300 men managed to escape. Unified by their hatred for their German captors, Britons, French, Belgians, Dutch, and a handful of Americans, shared secrets, tools, and information to break out from this unforgiving prison. Join veteran prisoners as they revisit Colditz and retell their thrilling and dangerous sagas of escape, unearth hidden caches of tools, and discover traces of trapdoors and tunnels.

1 hr. **WG2803 $19.95**

The Science of Crime Boxed Set

Serial criminals wield a particular brand of terror. Fortunately for us, scientific sleuths are on their trail. Includes *The Bombing of America, Mind of a Serial Killer* and *Hunt for the Serial Arsonist*. 3 hrs. on 3 cassettes **WG164 $49.95**

Search for the Lost Cave People

Discover a lost civilization that inhabited caves high on the isolated cliffs of Southern Mexico nearly 1,000 years ago. The tantalizing clues, including graphic evidence of ritual child sacrifice and a sophisticated writing system, shed new light on this mysterious people, the Zoqui.
1 hr. **WG2507 $19.95**

Secrets of Lost Empires Boxed Set

Uncover the secrets of ancient civilizations as *NOVA* journeys to five archaeological sites where teams of experts use traditional techniques to test their hypotheses. Includes *Colosseum, Inca, Obelisk, Stonehenge* and *Pyramid*. 5 hrs. on 5 cassettes **WG182 $69.95**

Secrets of Lost Empires II Boxed Set

Filled with powerful recreations and revealing insights, this ambitious *NOVA* series examines five ancient civilizations and their unique impact on the past...and on the future. Includes *Medieval Siege, Pharaoh's Obelisk, Easter Island, Roman Bath* and *China Bridge*.
5 hrs. on 5 cassettes **WG898 $69.95**

Secrets of the Psychics

Are some of us born with mysterious powers—able to move objects at will, read a person's thoughts, even cure physical ailments with the power of the mind? Follow master magician James Randi as he uncovers the secrets about psychics.
1 hr. **WGW703 $19.95**

Secrets of Making Money

Learn the secrets of counterfeiting—made easier by today's technology—and find out what the Feds are doing to fight back.
1 hr. **WG2314* $19.95**

Submarines, Secrets and Spies

NOVA lifts the veil on deadly, mysterious submarine accidents and high-risk spy missions through candid interviews with Soviet and U.S. military personnel, shocking underwater footage and recently declassified film and documents. 1 hr. **WG2602 $19.95**

NEW! Sultan's Lost Treasure

In the middle of the South China Seas, a six-hour voyage from the tiny, oil-rich Sultanate of Brunei, prospectors spot an ancient shipwreck on the seabed, half-swallowed up by sand. An international team of archaeologists dives far down and begins to retrieve a unique treasure—not gold or silver, but more than 12,000 intact pieces of Chinese porcelain dating from the 14th century AD. Join divers as they salvage the wreck from the teeth of pirates, looters, and the beds, as well as reconstruct the story of the world's first international trading network—the ultimate predecessor of today's global marketplace.
1 hr. WG2801 $19.95

Three Men and a Balloon

For a few diehard daredevils, it's "the last great challenge in aviation"—to fly a balloon non-stop around the world. Follow one of the foremost teams in a hair-raising race against time, technology, and hot competition.
1 hr. **WG2313 $19.95**

Titanic's Lost Sister

Search for the wreck of the *Britannic* and explore the clues as to how it sank. Four years after the *Titanic* went down, the *Britannic* sank in just one hour, despite an overhaul to meet post-*Titanic* standards. 1 hr. **WG2402 $19.95**

*No Retail Packaging

Treasures of the Sunken City
It's an undersea adventure in Cleopatra's erstwhile capital: Alexandria, Egypt, where marine archaeologists are frantically salvaging mysterious stone ruins from the harbor floor.
1 hr. **WG2417 $19.95**

UFOs: Are We Alone?
Using rare UFO footage, *NOVA* investigates the claims of sightings. 1 hr. **WGW262 $19.95**

NEW! Vanished!
On August 2, 1947, a primitive airliner converted from a World War II Lancaster bomber took off from Buenos Aires. The airliner, named *Stardust*, was due to cross the Andes en route to Santiago, Chile. It never arrived. No wreckage was ever found and the case of the vanished *Stardust* soon became one of aviation's most celebrated unsolved mysteries. Then in 1998, two mountaineers were startled when they stumbled across a huge engine high in the Andes. Join *NOVA* on this gripping high adventure and scientific detective story.
Educational use only. 1 hr. **WG2802 $19.95**

The Vikings

This riveting two-hour special investigates a new image of the Vikings that goes far deeper than their savage stereotype as raiding marauders. Faithful replicas of their magnificent ships, life-like computer animation and fascinating recreations reveal the Vikings as canny merchants, expert shipbuilders, superb artisans, and bold colonizers of lands that lay beyond the edge of the known world. 2 hrs. **WG958 $19.95**

Voyage of Doom
The recent discovery of *Belle*, part of the fleet of fanatical French explorer Robert La Salle, has been called the most important shipwreck find in North America. Lying mud-covered and remarkably preserved on the bottom of a Texas bay, *Belle*'s final resting place was unfortunate for La Salle, but incredible for historians and archaeologists. Join the unprecedented excavation effort as *NOVA* reveals *Belle*'s vivid history, incredible artifacts and mysterious details. 1 hr. **WG2616 $19.95**

Warriors of the Amazon
See a rare glimpse of life today for the Yanomami, who live in a remote and inhospitable part of the Amazon rain forest. 1 hr. **WG2309 $19.95**

Life Science

All-American Bear
Share a year in the life of the North American black bear—mating, playing, foraging for food and hibernating. 1 hr. **WG1520* $19.95**

Animal Hospital

Go behind the scenes for this offbeat, sometimes humorous, sometimes sad portrait of pets, their owners and their vets and the drama that unfolds everyday in homes, zoos and veterinary hospitals. 1 hr. **WG2504 $19.95**

Animal Impostors
A gnarled twig. A stretch of sand. A shadow. Suddenly they twitch—or lunge—and you realize you've been taken in by a cleverly disguised animal. Some of the most astonishing scenes on television. 1 hr. **WG909* $19.95**

The Brain Eater
Scientists race to determine whether a variant of mad cow disease spells a deadly epidemic for humans. *Educational use only.*
1 hr. **WG2505* $19.95**

Brain Transplant
NOVA follows a remarkable, little-known medical detective story, leading from an inexplicable paralysis among drug abusers to a bad batch of synthetic heroin to a research breakthrough in understanding Parkinson's Disease, to the prospect of curing brain diseases with fetal implants.
Educational use only. 1 hr. **WG1918* $19.95**

Can Buildings Make You Sick?
Join *NOVA*'s quest to uncover baffling cases of bad air found in offices, schools, homes and even hospitals! *Educational use only.*
1 hr. **WG2217* $19.95**

NEW! Cancer Warrior
Cancer Warrior is the story of an impassioned surgeon, Dr. Judah Folkman, and his struggle to pioneer a cancer treatment that for years went against the grain of many in the cancer research community. Dr. Folkman suggested that tumors cannot grow beyond the size of a pinhead without a blood supply to nourish them—and, if that blood supply could be blocked in some way, tumor growth could be stopped. And after years of patient detective work, a scientist in Folkman's lab found Endostatin, which was proven to wipe away tumors in mice without side effects or eliciting drug resistance. But will it be as successful in humans? *NOVA*'s cameras go behind the scenes to witness the first clinical trials designed to find that out, and to interview Dr. Folkman, who has never before been filmed for television. 1 hr. **WG2805 $19.95**

City of Coral
Dive into the beauty and wonder of a Caribbean coral reef. 1 hr. **WG1006* $19.95**

Coma

In a gripping real-life drama, *NOVA* follows famous neurosurgeon Jam Ghajar as he struggles to save a young boy with massive head trauma, using simple but crucial techniques that are dangerously absent from most hospitals across the country.
1 hr. **WG2411 $19.95**

NEW! Cracking the Code of Life
In July 2000, scientists made an announcement that triggered front-page headlines around the globe. The goal that was said to be as challenging as landing Neil Armstrong on the moon — "reading" over 3 billion chemical "letters" that make up human DNA — had been accomplished, and far more swiftly than anyone expected. In this two-hour special, *NOVA* investigates the implications of the genome project, and explores the impact of this new knowledge on everyone's lives during the next century. Will the ability to tests for genetic conditions in the womb prevent dreaded inherited conditions? Or will it create a demand for "perfect" children? And ultimately, does our future really lie in our genes?
2 hrs. **WG2909 $19.95** *Available Spring 2001.*

Dinosaurs of the Gobi
NOVA accompanies an American Museum of Natural History expedition to the Gobi Desert. The trip relives the exploits of the Museum's dashing explorer of the 1920s, Roy Chapman Andrews—said to be the real-life model for Indiana Jones.
Educational use only. 1 hr. **WGW2102* $19.95**

Dinosaur Hunt Boxed Set
Of all the creatures that ever walked the earth, none captures the human imagination like the dinosaur. To some of us they are almost mythical, a modern-day version of the dragons and monsters of fairy tales. But to scientists they hold a different fascination, offering important clues to the mystery of the evolution of life. Includes *Curse of T. rex*, *Case of the Flying Dinosaur* and *T. rex Exposed*.
3 hrs. on 3 cassettes. **WG737 $39.95**

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Dying To Be Thin

Tormented by an irrational fear of being fat, an estimated eight million young women are torturing themselves—sometimes to death. *Dying To Be Thin* introduces you to students, ballet dancers, fashion models and other young women who are seeking recovery or have conquered their disease. Discover how leading eating disorder specialists are making dramatic advances in the diagnosis and treatment of these two devastating diseases.
Educational use only. 1 hr. **WG2707 $19.95**

Ebola: The Plague Fighters

The Ebola virus and its devastating impact is profiled as *NOVA* travels behind the quarantine line to observe the scientists battling to contain this most deadly of viruses. 1 hr. **WG2304 $19.95**

Garden of Eden

The Seychelles, often referred to as the Garden of Eden, is a stunningly beautiful island chain. This tropical archipelago off the coast of Kenya is home to a dazzling array of exotic plants and animals and is also a scientific wonderland due to the incredibly unspoiled nature of the islands and their wildlife.
1 hr. **WG2714 $19.95**

The Great Wildlife Heist

NOVA goes undercover with a U.S. government sting that breaks open an international parrot-smuggling ring, landing some surprising suspects.
Educational use only. 1 hr. **WG2111* $19.95**

Island of the Spirits

Mystical, magical and marvelous, Japan's northernmost island, Hokkaido, is filled with steaming lakes, fairy tale forests and wildlife as varied and unique as its terrain. Dazzling photography captures a year in the life of its rare inhabitants.
Educational use only. 1 hr. **WG2614 $19.95**

Japan's Secret Garden

Follow a year in the life of a Japanese farm located on the shores of Lake Biwa, one of Japan's most pristine freshwater lakes. See how local farmers have developed a unique balance between humans and nature that continues to support rice fields and catfish ponds after over 2000 years of agriculture. 1 hr. **WG2716 $19.95**

Kingdom of the Seahorse

Witness a remarkable fish whose male becomes pregnant and gives birth. Tour the magical and complex world of the seahorse—from an underwater enclave in Australia to a village in the Philippines dependent on the seahorse for survival. 1 hr. **WG2410 $19.95**

Life's First Feelings

A look at babies' emotional responses, clues about developing personality traits and how parents help with socialization.
1 hr. **WG9304* $19.95**

Little Creatures Who Run the World

Peer close-up into the worlds of the most amazing ants and understand why some believe ants are the most successful life form on earth.
1 hr. **WG2203 $19.95**

Mammoths of the Ice Age

Ten thousand years ago a world frozen in ice began to thaw, marking the beginning of the end for the great woolly mammoth. But what effect did humans have on these huge beasts? Frozen bodies and houses made of tusks are just some of the amazing new finds. Now scientists are piecing together a picture of the life our ancestors shared with the woolly mammoth.
Educational use only. 1 hr. **WG2201* $19.95**

MD: The Making of a Doctor

In this two-hour special, *NOVA* follows seven aspiring doctors as they undergo the exhilarating and rigorous years of medical training.
2 hrs. **WG2207 $19.95**

The Miracle of Life

This Emmy® award-winning classic brings you along on an incredible microphotographic voyage through the human body as a new life begins, including the moment of conception.
1 hr. **WG001 $19.95**
DVD 1 hr. **WG799 $19.95**

Mystery of the Animal Pathfinders

Travel to bird feeding grounds in Brazil, bat caves in Mexico and eel habitats in Maine to understand the mystery of animal migration.
1 hr. **WGW710* $19.95**

Night Creatures of the Kalahari

When the sun sets over southern Africa, the grasslands' strangest and most secretive residents sneak out from their lairs. Witness bush babies, meerkats, striped polecats, brown hyenas, flying termites, and more rarely seen exotic creatures. 1 hr. **WG2501 $19.95**

Ninety in the 90s

Be inspired as the most senior of our citizens offer a unique perspective on their lives and the century's dramatic moments.
1 hr. **WG080* $19.95**

The Perfect Pearl

NOVA takes a deep look inside the pearl's precious world and reveals how these wonders of nature are fast becoming wonders of science. Trace the pearl's fascinating history and see how modern pearl cultivators are coping with complex natural, technological and environmental obstacles. 1 hr. **WG2507N $19.95**

The Private Lives of Dolphins

Discover the deep-sea drama of life for the ocean's most charming and sophisticated mammals. 1 hr. **WG1917 $19.95**

Rescuing Baby Whales

Join the dramatic rescue of young, stranded pilot whales, and learn what is behind this puzzling phenomenon. 1 hr. **WG1908* $19.95**

Shark Attack!

Are sharks developing a taste for human flesh? Join *NOVA* scientists as they discover some surprising truths about the way sharks kill.
1 hr. **WG2316 $19.95**

Siamese Twins

Witness the intricate plans and delicate operations that give independence to two young girls who were born joined at the pelvis.
1 hr. **WG2204* $19.95**

Stranger in the Mirror

NOVA explores the nature of human perception through the puzzling condition called visual agnosia—the inability to recognize faces and familiar objects—familiarized by Oliver Sacks' book *The Man Who Mistook His Wife for a Hat.*
Educational use only. 1 hr. **WGW709* $19.95**

Surviving AIDS

Journey with *NOVA* to meet the scientists, physicians, and courageous patients whose cutting-edge experimentation and heroic acts will help achieve the ultimate goal: transforming every AIDS patient into a long-term survivor.
1 hr. **WG2603 $19.95**

NEW! Survivor MD

Ten years ago – long before the current trend of "reality TV" – *NOVA* began a unique project to document the frustrating, exhausting, and exhilarating process of becoming a doctor. Now the fourth program in this unique series, *Survivor MD* presents an intimate portrait of the young doctors' growing expertise, continuing struggles to balance professional and family life, and their reflections on an arduous and uplifting decade of training. 3 hrs. on 2 cassettes.
WG2806 $29.95 *Available Spring 2001.*

Tales from the Hive

Using specially developed camera lenses, *NOVA* brings you the most intimate—and most spectacular—portrayal of a working bee colony ever filmed. 1 hr. **WG2701 $19.95**

Treasures of the Great Barrier Reef

Visit Australia's greatest natural wonder, and view the undersea world's brilliant colors and extraordinary inhabitants. 1 hr. **WG2215 $19.95**

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The Universe Within

Travel on an extraordinary visual tour inside the human body, with microphotography and computer animation achieved by the creators of *The Miracle of Life*. 90 min. *Educational version:* **WGZ206A* $19.95** 1 hr. **WGZ206 $19.95**

Wild Europe Boxed Set

Part travel adventure, part nature expedition, *Wild Europe* presents an untamed, unexpected experience that reveals a Europe few have ever seen. This stunningly filmed special unveils hundreds of European species in their natural habitats. Includes *Wild Seas, Wild Mountains, Wild Arctic, Wild Grasslands, Wild Origins* and *Wild Cities*.
6 hrs. on 6 cassettes **WG653 $69.95**

The Wonder of Life Boxed Set

Hidden from the human eye, the wonder of life unfolds in, on and around us with startling beauty and unexpected drama. Includes *The Odyssey of Life Set (The Ultimate Journey, The Unknown World, The Photographer's Secrets)* and *The Miracle of Life*.
4 hrs. on 4 cassettes **WG177 $59.95**

Physical Science

The Best Mind Since Einstein

A profile of the late Richard Feynman—atomic bomb pioneer, Nobel prize-winning physicist, acclaimed teacher and all-around eccentric. *Educational use only.* 1 hr. **WGW708* $19.95**

Einstein Revealed

Journey into the life and thoughts of a genius—through interviews with "Einstein" (Andrew Sachs of *Fawlty Towers*), insight from experts, and some whimsical computer animation.
2 hrs. **WG2311 $19.95**

Fast Cars

Follow a racecar driver and engineers as they design a faster car. 1 hr. **WG2208 $19.95**

Race to Catch a Buckyball

Learn about the chance discovery of an entirely new form of carbon—soccer-ball-shaped miraculous molecules called Buckyballs. *Educational use only.* 1 hr. **WG2216* $19.95**

Roller Coaster!

The thrill of the world's greatest rides and the science that creates them. *Educational use only.*
1 hr. **WGW706* $19.95**

Super Bridge

Take a look at "the bridge of the future" and play sidewalk supervisor on one of the world's most remarkable and risky bridge projects—the building of the elegant, cable-stayed Clark Bridge spanning the Mississippi at Alton, Illinois. 2 hrs. **WG2416 $19.95**

Time Travel

Join scientists Kip Thorne, Stephen Hawking and others to see a theoretical time machine that may someday make time travel a reality. *Educational use only.* 1 hr. **WG2612* $19.95**

Mathematics

Trillion Dollar Bet

NOVA follows the riches-to-rags story of two Nobel Prize-winning economists whose mathematical formula to accurately predict financial markets brought them both notoriety and disgrace. *Educational use only.*
1 hr. **WGZ704 $19.95**

The Proof

Princeton math whiz Andrew Wiles spent eight secluded years perfecting the proof of Fermat's Last Theorem, a famous enigma that had stumped experts for 300 years. Follow a fascinating tale of obsession, secrecy, brilliance—and one man's inspiring single-minded quest. *Educational use only.* 1 hr. **WG2414 $19.95**

NOVA Field Trips

Amazing Animals

From bugs to bats and more. Includes *All-American Bear, Little Creatures Who Run the World* and *Mystery of the Animal Pathfinders*. Teacher's guide included. 3 hrs. on 3 cassettes.
WG089 $49.95

Creatures of the Sea

Dive deep for an underwater visit with the ocean's most fascinating creatures. Includes *Shark Attack!, Private Lives of Dolphins* and *Treasures of the Great Barrier Reef*. Teacher's guide included. 3 hrs. on 3 cassettes.
WG091 $49.95

Discovering Ancient Cultures

Investigate new clues for ancient cultures. Includes *This Old Pyramid* (90 min.), *Vikings in America*, and *Warriors of the Amazon*. Teacher's guide included. *Educational use only.*
3.5 hrs. on 3 cassettes. **WG092 $49.95**

The Doctors

Watch doctors operate behind the scenes. Grades 7 and up. Includes *MD: The Making of a Doctor* (2 hrs.) and *Ebola: The Plague Fighters*. Teacher's guide included.
3 hrs. on 2 cassettes. **WG104 $49.95**

The Earth

A close-up look at some of Earth's most spectacular phenomena. Includes *In the Path of a Killer Volcano, The Day the Earth Shook* and *Flood!*. Teacher's guide included. 3 hrs. on 3 cassettes. **WG110 $49.95**

Exploring Space

View the universe from new perspectives. Includes *Countdown to the Invisible Universe, Death of a Star* and *Rescue Mission in Space*. Teacher's guide included. 3 hrs. on 3 cassettes.
WG107 $49.95

Fast Physics

Understand the thrill and power of motion. Includes *Roller Coaster!, Fast Cars* and *Daredevils of the Sky*. Teacher's guide included. *Educational use only.* 3 hrs. on 3 cassettes.
WG086 $49.95

Flight

Feel the exuberance and the thrill of flight. Includes *Top Gun Over Moscow, Three Men and a Balloon* and *Aircraft Carrier!*. Teacher's guide included. 3 hrs. on 3 cassettes. **WG111 $49.95**

The Human Body

The intricate wonders of the human body are revealed in extraordinary visual detail. Includes *The Miracle of Life, The Universe Within* and *The Ultimate Journey*. Teacher's guide included.
3 hrs. on 3 cassettes.
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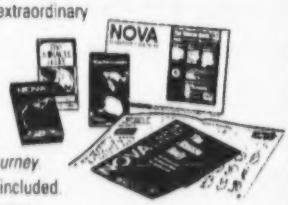

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In Search of Human Origins
The development of the human race. Includes *The Story of Lucy, Surviving in Africa* and *The Creative Revolution*. Teacher's guide included. 3 hrs. on 3 cassettes. **WG109 $49.95**

The Mysteries of the Mind
Explore the intriguing phenomena of perception, psychological development, and reports of alien abductions. Includes *Kidnapped by UFOs, Secret of the Wild Child,* and *Stranger in the Mirror*. Teacher's guide included. *Educational use only.* 3 hrs. on 3 cassettes. **WG105 $49.95**

The Planets, The Stars and More
Visit extraordinary places in the universe. Includes *Venus Unveiled, Eclipse of the Century* and *Doomsday Asteroid*. Teacher's guide included. *Educational use only.* 3 hrs. on 3 cassettes. **WG087 $49.95**

Scientific Detectives
Search for answers to intriguing mysteries. Includes *Codebreakers, Hunt for the Serial Arsonist* and *In Search of the First Language*. Teacher's guide included. *Educational use only.* 3 hrs. on 3 cassettes. **WG090 $49.95**

Secrets of Lost Empires
Travel to five archaeological sites with *NOVA* and their teams of experts. The mission? To replicate ancient engineering feats—using traditional tools. Includes *Stonehenge, Inca, Obelisk, Colosseum* and *Pyramid*. Teacher's guide included. 5 hrs. on 5 cassettes. **WG304 $69.95**

Wild Weather
Join "stormchasers" on a journey into danger to learn how to tame nature's fury. Includes *Lightning!, Tornado!* and *Hurricane!*. Teacher's guide included. 3 hrs. on 3 cassettes. **WG088 $49.95**

Instructional Videos

Fast Cars Modules Set
Understand cars to understand physics. *Invisible Forces of Winds* puts students at the controls of an Indy 500 race car to demonstrate aerodynamics. *To Survive at High Velocity* demonstrates how vectors show how "corners make the driver and the car." *Test Day* lets you understand the complexity of race cars by testing every variable on the track. In *A Racing Engine for the Indy 500,* two companies battle to harness energy to create power. Teacher's guide included. *Educational use only.* 1 hr. on 4 cassettes. **WG2208A* $49.95**

Learning That Works
A unique three-video set and an 80-page comprehensive facilitator's guidebook that demonstrates the benefits of learning science with real world applications. *Learning That Works* presents options for teaching science that integrates what students learn in their science classes with what they do at work or in the community. 2 hrs. on 3 cassettes **WG983 $99.95**

Physics By Inquiry
Physics By Inquiry: A Video Resource illustrates a hands-on, inquiry-oriented approach to the study of science that can strengthen teacher's understanding of basic physics and physical science and help them begin to teach through inquiry. 90 min. **WG969 $19.95**

Science First Hand Set
Observe teachers and students at work. *Structures* – Designing houses, bridges and towers to explore force, tension and compression. *Tops and Yo-Yos* – Understanding rotational motion by designing and building tops and yo-yos. *Waterwheels* – Simple machines that demonstrate efficiency, speed and testing variables. Teacher's guide included. *Educational use only.* 105 min. on 3 cassettes. **WG005 $39.95**

Science K-6: Investigating Classrooms
Step inside three elementary classrooms to see what teachers from around the country are doing to incorporate in-depth investigations into their science lessons. This library of nine videos and a 110-page Facilitator's Guide are an invaluable resource in learning and refining the fine craft of teaching by observing and discussing real classrooms. The teachers offer themselves and their students as case studies in an effort to raise questions and inspire discussions about what it takes to prepare scientifically literate students. 7 hrs. on 9 cassettes. **WG545 $199.95**

Ordering Information

Phone
Call 1-800-949-8670, and mention keycode "0300" (8 AM to 3 AM, EST, 7 days a week). Please have your American Express, VISA, MasterCard or Discover card ready.

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Fax your order with credit card payment or purchase order to: Dept. 0300, 1-802-864-9846

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The *NOVA Teacher's Guide* is produced by the Educational Print and Outreach department of the WGBH Educational Foundation.

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The NOVA television series is produced by WGBH Boston, which is solely responsible for its content, and distributed by the Public Broadcasting Service.

Major funding for NOVA is provided by

Northwestern Mutual FINANCIAL NETWORK™ PARK FOUNDATION Sprint. Sprint PCS®

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Major funding is provided by Northwestern Mutual Financial Network, PARK Foundation, Sprint, Sprint PCS

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Title: NOVA Teacher's Guide (Spring 2001)	
Author(s): WGBH Boston	
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